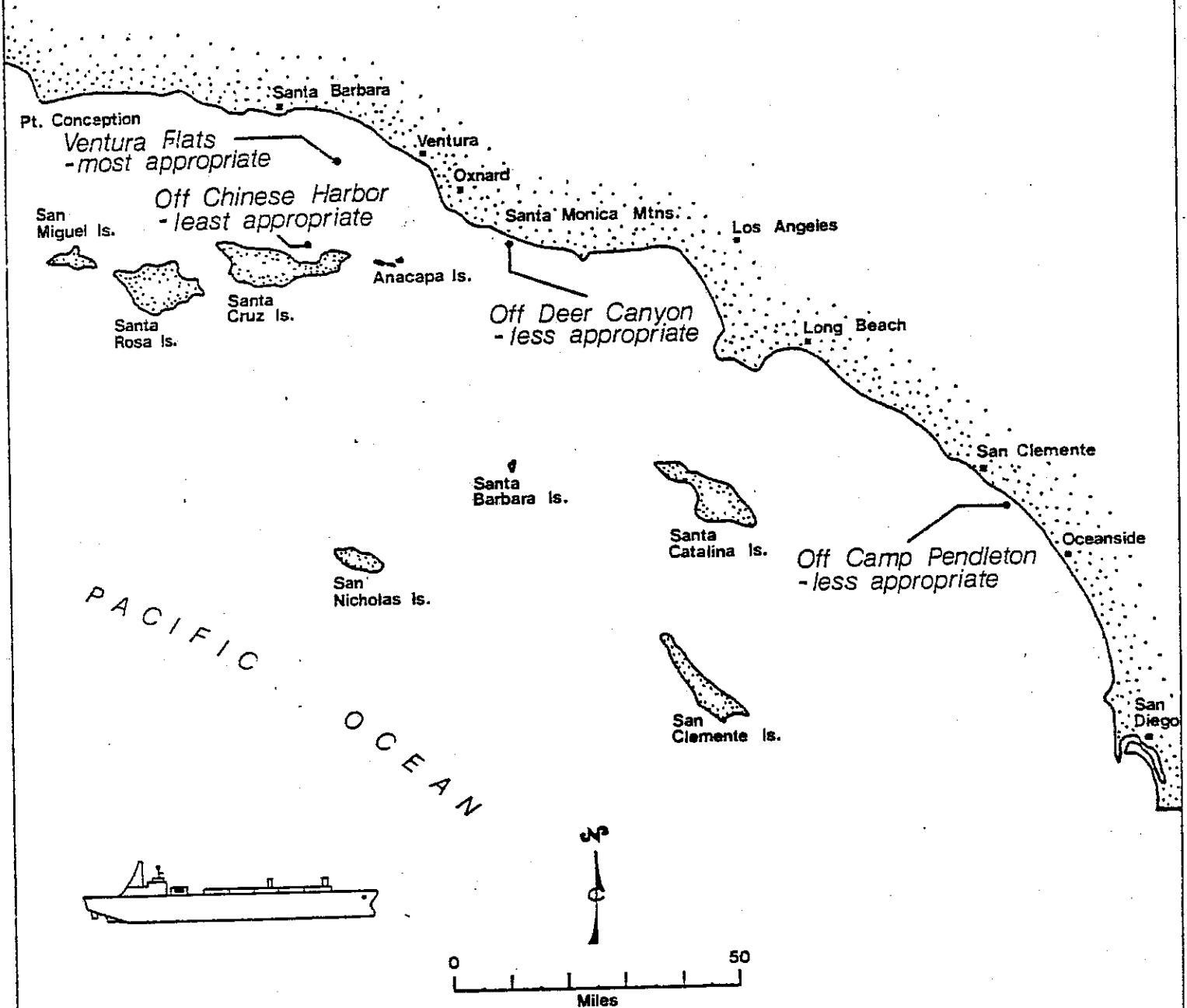


California Coastal Commission

Offshore LNG Terminal Study

September 15, 1978



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Note: The Appendices are presented in a separate volume available on request at the Commission's San Francisco office.

OFFSHORE LNG TERMINAL STUDY

SUMMARY AND MAJOR CONCLUSIONS

Introduction

This report presents Coastal Commission conclusions on potential offshore LNG terminal sites and types of terminals. The LNG Terminal Act of 1977 requires the Commission to present its judgment to the Governor, Legislature, Energy Commission, and Public Utilities Commission on the most appropriate sites for an LNG terminal offshore the California mainland and the most appropriate type or types of LNG terminals that could be located on such sites.

Study Approach

The Commission contracted with three designer-builder engineering firms to develop conceptual designs for one floating and two sea bottom-supported offshore LNG terminals at three specific sites offshore California. These designs permitted credible conceptual engineering and environmental evaluations of specific type terminals on actual potential offshore sites. At the same time, staff and consultants screened the entire California offshore area for zones where it might be feasible to site a terminal because of favorable winds, waves, water depths, and other factors. Seven zones off Southern California survived this initial screening. These zones have been evaluated with respect to terminal engineering problems, operational reliability in delivering gas to California, public safety, adverse impacts on marine and coastal resources, conflicts with existing recreational, military and other uses of offshore areas, terminal system cost, and the problems and time that could face obtaining required approvals and starting terminal operation.

Copies of the staff draft of this document were distributed in July 1978 to over 700 interested persons, including State and Federal agency staff, members of the gas transportation and offshore construction industries, and the general public, with a request for written or oral comment. During August, public non-technical workshops on the study were held near the proposed sites and a technical workshop was held in Los Angeles to inform the public and answer questions. The Commission then held a public hearing on the study on August 15, 1978. Final revisions of the study were adopted by the Commission on September 5, 1978.

Relation of the Onshore Site Ranking to This Study

On May 24, 1978 the Coastal Commission adopted a ranking of four potential mainland onshore LNG terminal sites and transmitted that ranking to the Public Utilities Commission. The LNG Terminal Act requires the Commission to base that ranking on the policies of the California Coastal Act of 1976, whose most important policies protect public access and recreation along the coast, natural marine and onshore plant and wildlife resources, and the scenic quality of California's coastal areas. The issues of when a terminal could be put into operation or whether a site would be readily available for a terminal were given low

weight in the onshore site ranking, because the Act requires the PUC to analyze these issues. In this offshore LNG terminal study, however, the Coastal Commission must evaluate all aspects of offshore sites and terminals to judge overall "appropriateness." These aspects include site availability and likely opposition to terminal approvals, engineering feasibility and problems, safety, and cost, in addition to the impacts on objectives of the Coastal Act. After evaluating these aspects for sixteen combinations of sites and types of LNG terminals, one offshore site, with a floating type LNG terminal, seems to be "most appropriate."

The Most Appropriate Site

The most appropriate siting area for a liquefied natural gas (LNG) terminal off the shoreline of California appears to be in international waters of the southeast part of Ventura Flats. This area is more than 8 miles from the mainland in the eastern Santa Barbara Channel (Figure 1). Only the floating type of offshore LNG terminal of either the barge or semi-submersible type could be placed with confidence in this area because it is not dependent on favorable seismic and soil conditions of the sea bottom (Figure 2). Flexible moorings would connect the terminal to the sea bottom, but it would be supported by water and thus protected from earthquake shaking. A subsea bottom-supported terminal would also be appropriate on the site if foundation conditions are proven adequate.

Because of the site's distance from shore, a floating LNG terminal on the southeast Ventura Flats would have minimal adverse impacts on sensitive marine resources and public recreation along the coast. It would be visible on clear days from about 25 miles of coastline, but it would look like a large tanker and would be beyond the ten offshore oil production platforms in the area. Another advantage is that there would be a comparatively short underwater gas pipeline to the Oxnard area that would not cross major earthquake faults.

However, the LNG storage and LNG tanker operations of any offshore LNG terminal, even 8 miles from shore, would pose risks to public safety if an accident were to result in a large unconfined spill of LNG. Since Ventura, the closest urban area, is about 12 miles away, there would be a substantial safety zone. If a floating LNG terminal is proposed for this site, special safety measures should be taken relating to vessel controls, emergency anchors, availability of large tugs, and other equipment and operations to minimize risks of collisions and to insure that a floating terminal could not approach shore.

While southeast Ventura Flats has not been leased to oil companies for petroleum development, the area is under the jurisdiction of the federal government and there is no federal legislation at present enabling siting of an LNG terminal on the federal outer continental shelf (OCS). Congress is considering such

Ventura Flats

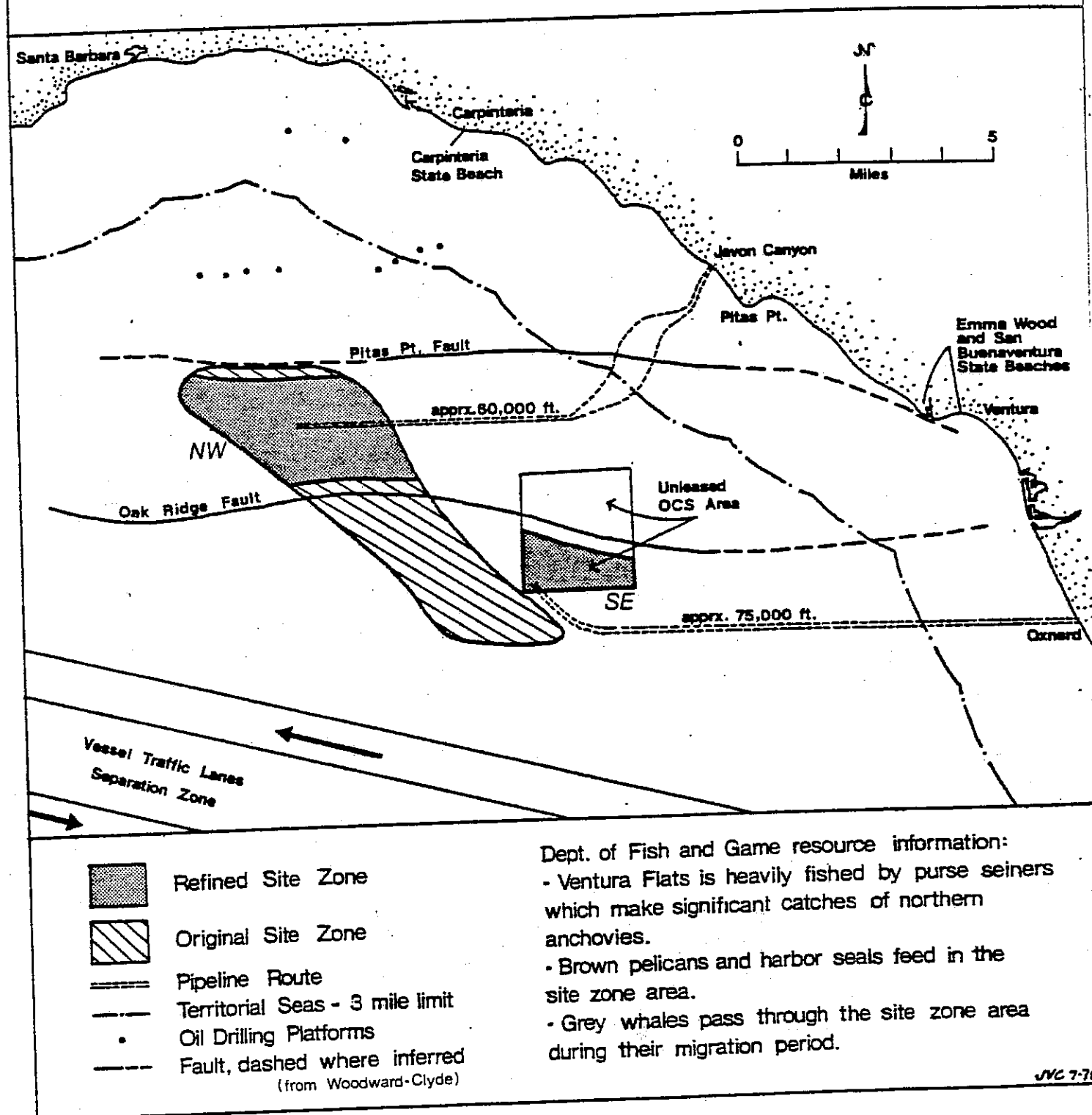


Figure 1

Types of Floating LNG Terminals and Moorings

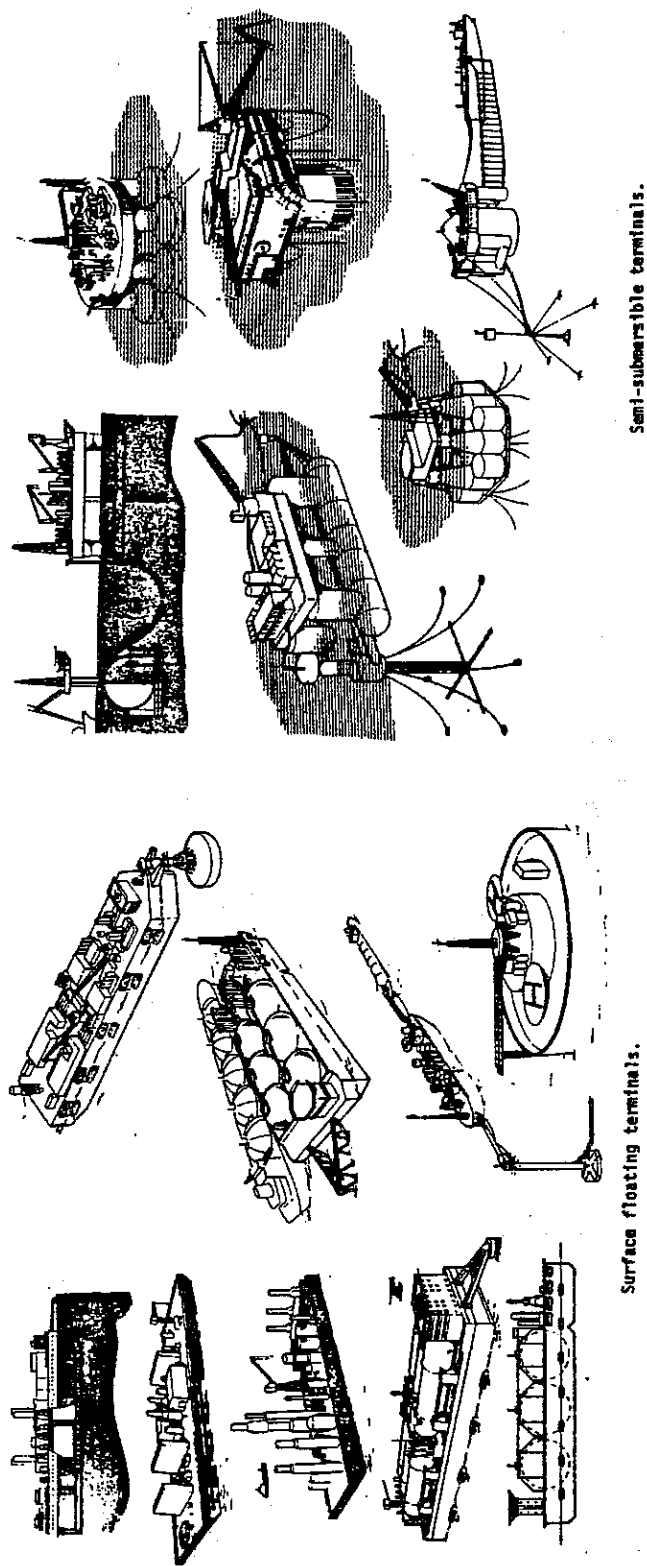
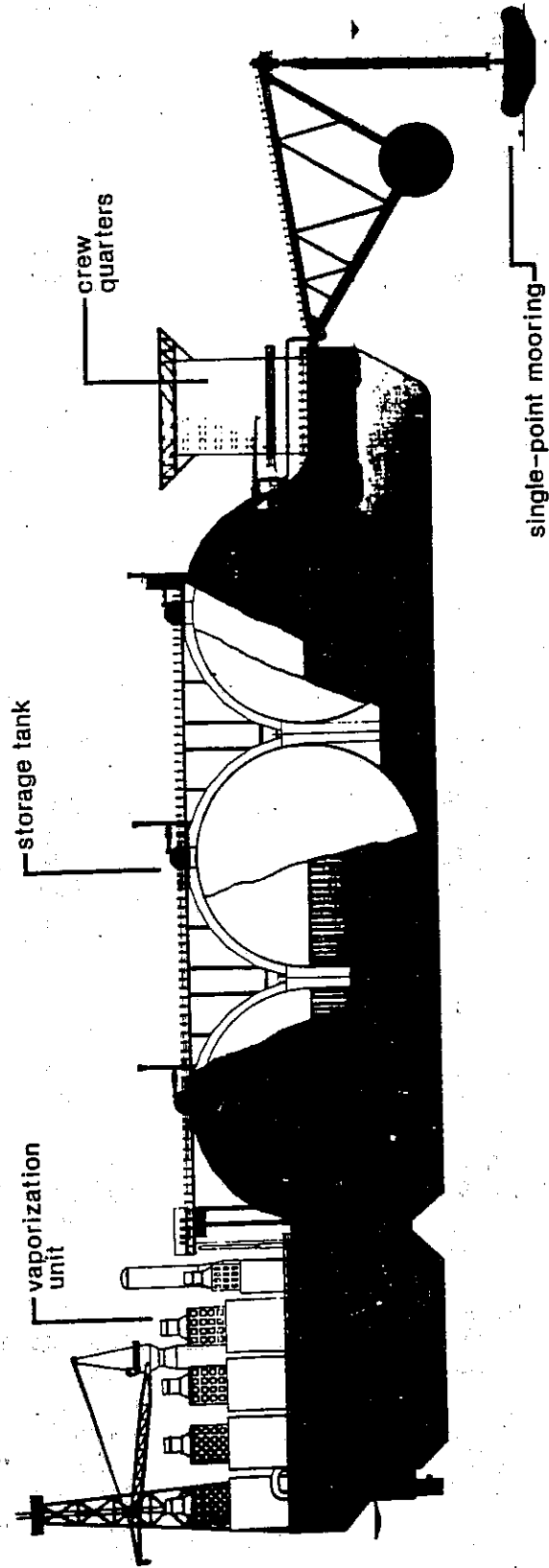


Fig. 2A



Floating Barge LNG Terminal

designed by Moss Rosenberg

Fig. 2B

legislation at present; no serious opposition has yet appeared, so prospects for passage seem favorable. Nevertheless, the lack of both a federal and state regulatory process for approving an offshore LNG terminal creates considerable uncertainty as to the full time it might take to obtain required approvals. If there is general support at all levels of government and limited opposition, it would take about 6 to 8 years to put a floating LNG terminal into operation on Ventura Flats from the time application preparation starts. This time estimate is optimistic. Given the experience of other major energy project applications, the time to approval could stretch out indefinitely. The total construction cost in 1978 dollars for a complete floating terminal and underwater and onshore pipeline connections to the California gas distribution system is estimated at about \$500 million. A floating type terminal would be built in a shipyard and towed to the offshore site, minimizing adverse environmental impacts of terminal construction. California has shipyards and drydock sites where the terminal structure could be built, but no LNG carriers have yet been built in the State. In order to avoid any question of their accuracy, the illustrative time and cost estimates in this study are based upon quotes by experienced out-of-State builders.

Site Screening and Geotechnical Problems

The other possible offshore LNG terminal siting areas and the bottom-supported types of offshore LNG terminals all have serious problems or disadvantages that make them less appropriate or unacceptable. After screening out most of the California offshore area because of unacceptable wind and wave conditions, infeasible water depths for a pipeline to shore, nearness to population concentrations, and conflicts with other uses of offshore areas, seven areas were selected for further evaluation: Ventura Flats, offshore Camp Pendleton, offshore Deer Canyon, three areas on or offshore Santa Cruz Island called Chinese Harbor, San Pedro Point, and Smugglers Cove, and one area at Santa Rosa Island called Bechers Bay (Figure 3). Terminal designs for sites on the two islands would be the same as designs for mainland onshore terminals. In the water areas both floating and bottom-supported type LNG terminals were evaluated.

There are a number of types of bottom-supported LNG terminal designs including shallow water designs and designs with the LNG storage underwater (Figure 4). Unlike a floating terminal, such rigid offshore terminals would have the advantage of stability while a tanker berths alongside, and the gas pipeline connections to the sea bottom would be more reliable. But because they are supported by the sea bottom, they are susceptible to earthquake shaking. They require special water depths and sea bottom characteristics.

This dependence on favorable sea bottom conditions is a major disadvantage because an LNG terminal would be both a potentially hazardous facility and a critical facility to the State's energy supply. Coastal California and the offshore areas are seismically active (Figure 5), and this activity means that extensive seismic evaluations would have to be conducted and a number of federal and state regulatory agencies would have to be convinced that earthquakes and other geotechnical factors present acceptable risks to the terminal before any bottom-supported offshore LNG terminal could be approved. The seismic evaluations of the seven offshore areas indicate that geotechnical factors severely limit where a bottom-supported offshore LNG terminal can be sited.

Offshore LNG Terminal Sites

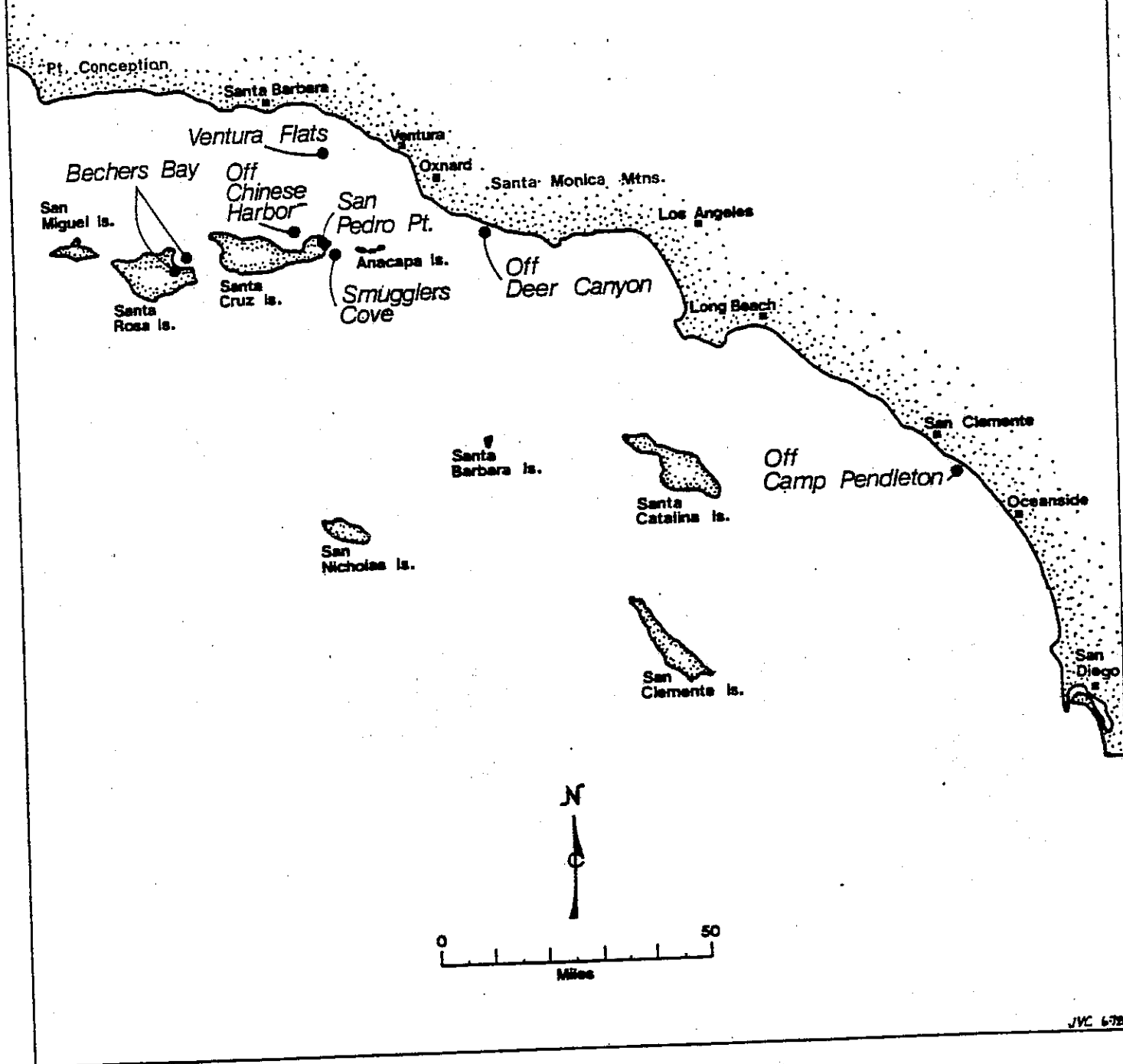


Figure 3

Types of Bottom Supported Offshore LNG Terminals

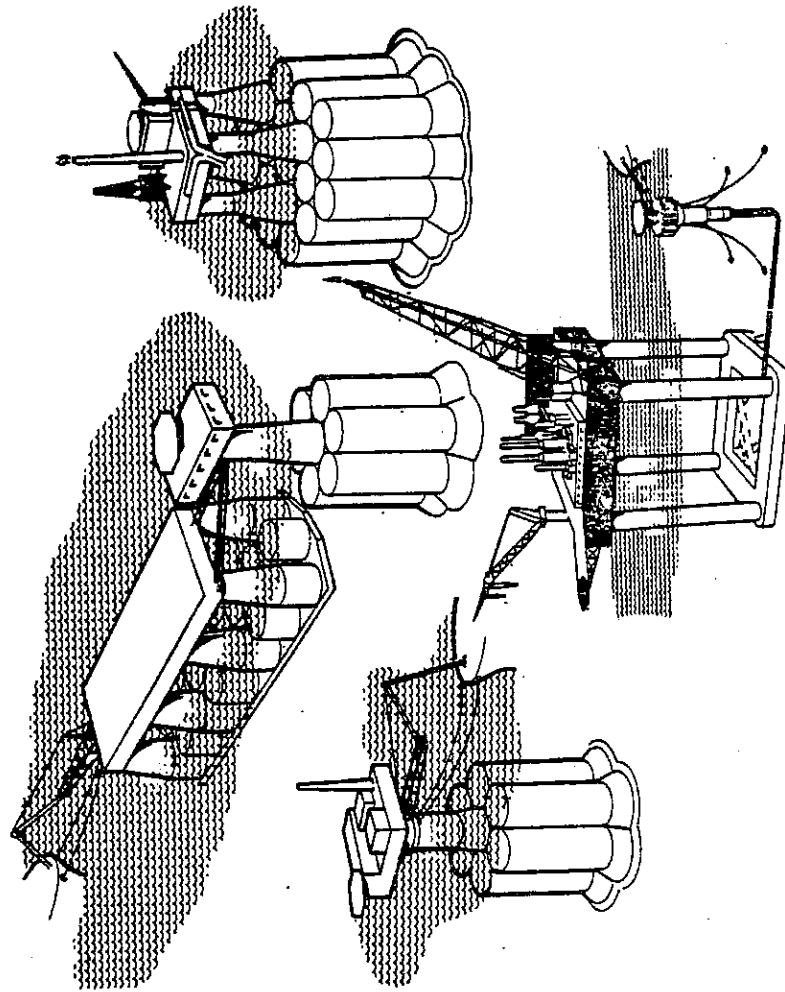


Figure 4

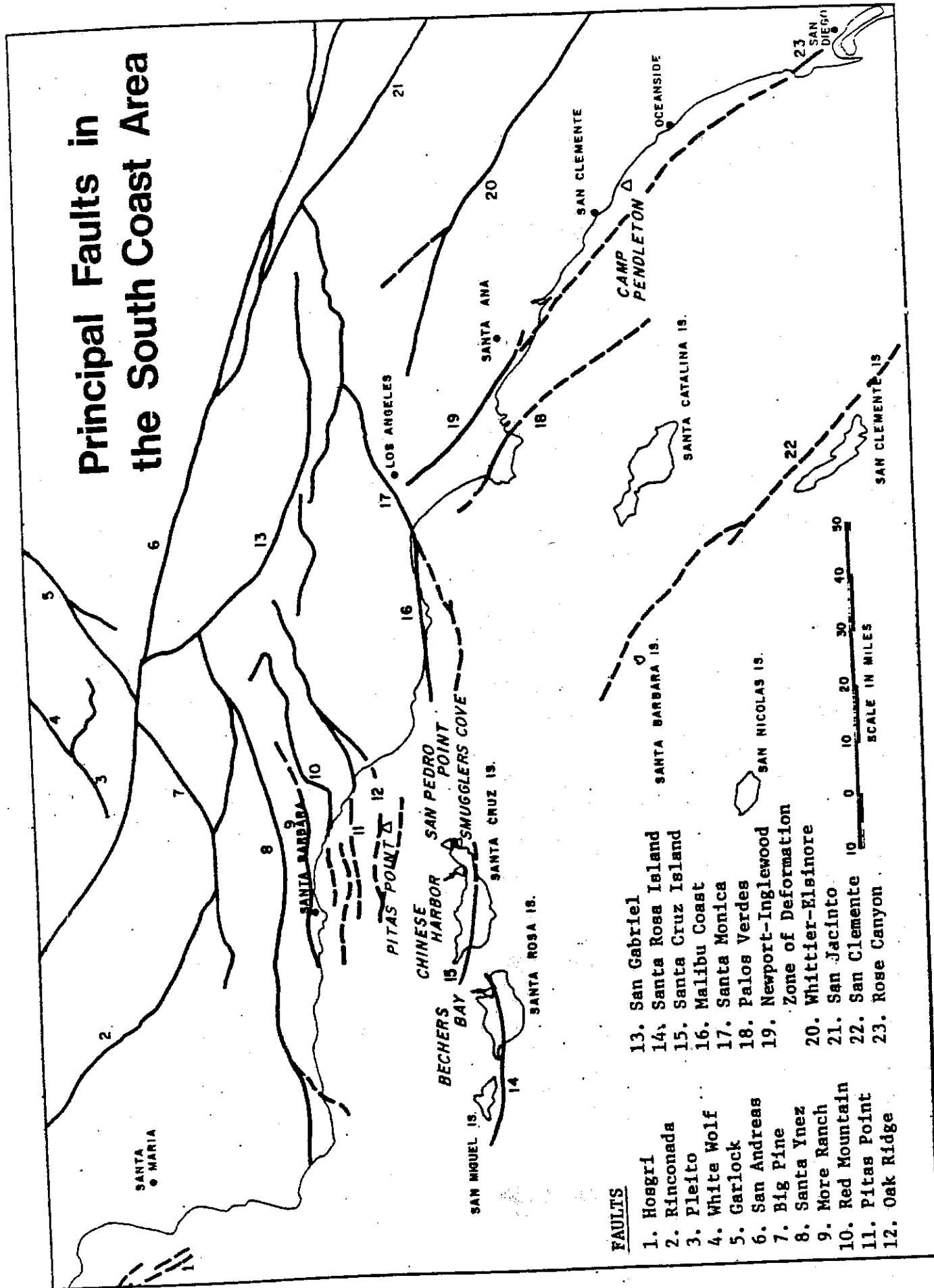


Figure 5

The evaluations provide moderate confidence that a bottom-supported terminal could safely and reliably be built on a part of the northwest section of Ventura Flats and off Camp Pendleton. Even there much more evaluation would be needed, and there would be the serious uncertainty of discovery of added faults any-time during the permitting process or during terminal operation. Thus the major advantage of a floating terminal over other onshore or offshore terminals is that only the base of the mooring system, and not other critical components, is susceptible to significant earthquake forces.¹

Site Evaluations

The site evaluations show many other factors that make the seven sites other than southeast Ventura Flats less appropriate or unacceptable. The major factors in the evaluations are listed in Table 1. They include (1) confidence in the feasibility of terminal and pipeline construction and in reliable tanker berthing and pipeline operation, (2) public safety, (3) conflicts with recreation, petroleum development and military uses of offshore areas, (4) adverse impacts on marine and coastal resources, (5) cost, and (6) the time it could take to put a terminal into operation. A summary of these evaluations is presented in Table 1.

Ventura Flats. The southeast portion of Ventura Flats, centered 12 miles west of Port Hueneme and eight miles from the nearest land, is judged the most appropriate site. Of the terminal types evaluated, a floating terminal is definitely appropriate for the site and a subsea bottom-supported terminal may be appropriate if the sea bottom can be shown to provide a secure foundation for such a tall, massive structure.

Either a floating or subsea bottom-supported terminal would be feasible but less appropriate on the northwest part of Ventura Flats. The area has already been leased to oil companies by the Interior Department and there may be an oil field there, the underwater gas pipeline to shore would have to cross over the Pitas Point earthquake fault, and the route for the pipeline onshore would be especially damaging to environmental resources since it must traverse coastal and interior canyons (Figure 1).

Offshore Deer Canyon. A floating terminal about one mile off Deer Canyon (Figure 6) would also be feasible but less appropriate because it would intrude on the recreational experience at popular Leo Carillo and Point Mugu State Parks and at the coastal part of the Santa Monica Mountains, which are proposed for national park status. It seems unlikely that the public safety aspects of such a terminal would be acceptable. It would be about 5 miles from the Point Mugu Naval Pacific Missile Test Center and the homes of northern Malibu, while within 4 miles are heavily used parks, children's camps, and the Pacific Coast

¹ Vertical earthquake forces are transmitted to floating structures but are estimated to be considerably smaller than the wave slamming forces for which such structures are routinely designed. Horizontal earthquake forces are "decoupled" from floating, flexibly moored structures.

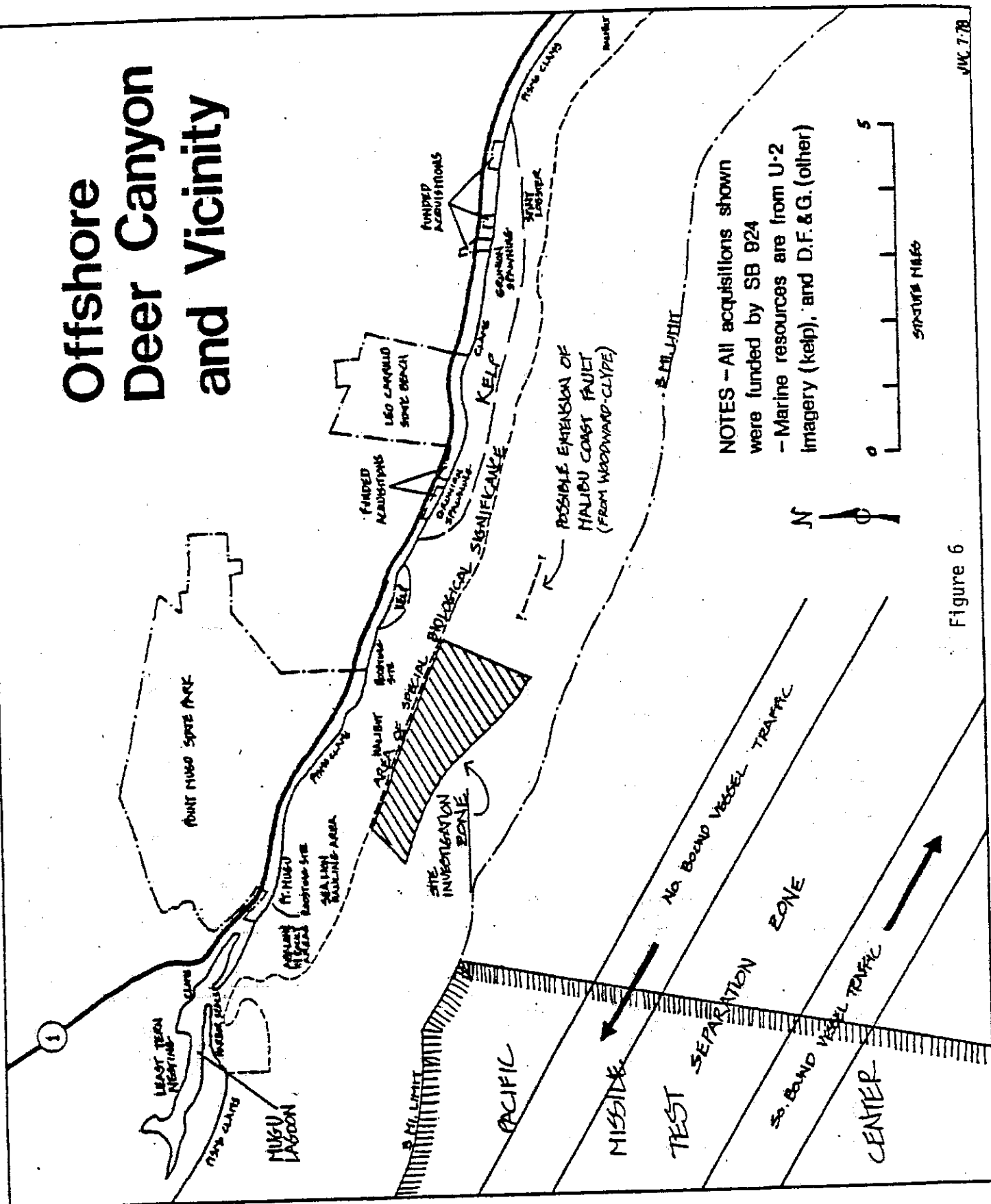


Figure 6

TABLE 1: Summary of Site Evaluations

	Ventura Flats SE		Ventura Flats NW		Off Deer Canyon	Off Camp Pendleton	
	Floating	Subsea	Floating	Subsea	Floating	Floating	Shallow Bottom
<u>Confidence in Construction Feasibility With Respect to Geotechnical (Mainly Seismic) Factors</u>							
--Terminal	High	Low	High	Medium	High	High	Medium
--Pipeline	High	High	High	High	Low	High	High
<u>Confidence in Reliability of Operations</u>							
--Berthing (weather)	92%	96%	92%	96%	97%	98%	94%
--Pipeline (seismic)	High	High	Medium	Medium	High	High	High
<u>Public Safety</u>							
--Distance to nearest 1,000 people	12 mi	12 mi	9 mi	9 mi	4-6 mi	7 mi	5.5 mi
--Activity nearby (3 mi)	Sparse	Sparse	Sparse	Sparse	Moderate	Intense	Intense
--Critical facilities	None	None	None	None	Pt. Mugu, 4 mi	San Onofre Nuclear Power Plant, 4 mi	
<u>Use Conflicts</u>							
--Recreational conflicts	None	None	None	None	Substantial	Moderate	Substantial
--Petroleum leases	None	Leased	Leased	Leased	Partly	None	None
--Military conflicts	None	None	None	None	Small	Substantial	
<u>Adverse Marine and Coastal Resource Impacts</u>							
--Fishing	Moderate		Moderate		Moderate	Small	Small
--Special species	Some disturbance		Some disturbance		Some dis.	Small	Small
--Compatibility	Acceptable		Acceptable		Very poor	Poor	Poor
--Construction	Small	Small	Small	Small	Small	Small	Substantial
--Onshore pipeline	Small	Small	Severe	Severe	Substantial	Small	Small
Cost, + 20% (1977-78 dollars)	\$489m	\$552m	\$507m	\$570m	\$454m	\$414m	\$431m
<u>Timing to Operation</u>							
--Minimum time to operation	6-7 yr	7-8 yr	6-7 yr	7-8 yr	6½ yr	6½ yr	8 yr
--Likely opposition	Moderate		Substantial		Severe	Extreme	Extreme
Preliminary Overall Judgment	Most appropriate	Appropriate if feasible	Less appropriate	Less appropriate	Less appropriate	Less appropriate	Less appropriate

 Box represents serious constraint

Off Chinese Harbor		Off Smugglers Cove		On San Pedro Point	Off Bechers Bay		Onshore Bechers Bay
Floating	Subsea	Floating	Shallow Bottom		Floating	Shallow Bottom	
High	Low	High	Low	Low	High	Low	Low
Probable, but not demonstrated					Questionable		
96%	97%	97%	96%	96%	94%	95%	95%
Medium	Medium	Medium	Medium	Medium	Low	Low	Low
24 mi	24 mi	23 mi	23 mi	21 mi	30 mi	30 mi	30 mi
Sparse	Sparse	Moderate	Moderate	Moderate	Sparse	Sparse	Sparse
None	None	None	None	None	None	None	None
Moderate	Moderate	Severe	Severe	Severe	Substantial		Substantial
None	None	None	None	None	None	None	None
Small	Small	Substantial		None	Substantial		Substantial
Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe
Substantial		Severe	Severe	Severe	Severe	Severe	Severe
Very Poor		Unacceptable		Unacceptable	Unacceptable		Unacceptable
Small	Small	Small	Substantial	Severe	Small	Substantial	Severe
Small	Small	Small	Small	Small	Small	Small	Small
\$565	\$628	\$524	\$545		\$659	\$680	
6½ yr	7 yr	No realistic figure					
Severe	Severe	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Barely acceptable		Not acceptable		Not acceptable	Not acceptable		Not acceptable

Highway. The advantage of this site is that it is within the three mile limit of State jurisdiction so no new federal legislation would be required to approve such a terminal. But strong opposition to this site would be likely and State approval, requiring both new legislation and application approval, seems highly doubtful. This site should be further considered only if an overwhelming need for LNG is shown and there are no other siting alternatives.

Offshore Camp Pendleton. Both a floating and shallow water bottom-supported type LNG terminal appear feasible off Camp Pendleton (Figure 7), but the geotechnical evaluations which found added traces of possible earthquake faults indicate only medium confidence that the bottom-supported type terminal could be sited there. Public safety problems would be serious since the LNG storage would be offshore and the terminal would be about 7 miles from San Clemente, 4 miles from Marine Corps barracks, and about 4 miles from the San Onofre Nuclear Power Plant. The site area, $1\frac{1}{2}$ to 3 miles offshore, would be visible from San Onofre State Park, Interstate 5, and a long stretch of the San Diego County coast. The site's major advantage, as with the onshore site at Horno Canyon ranked first by the Coastal Commission among four onshore sites, would be the small adverse impact on marine biological resources. This site is less appropriate than Ventura Flats since strong opposition to its use for an LNG terminal could be expected from the U.S. Navy and Marine Corps, which operate amphibious warfare training exercises in the area.

Channel Islands. All the sites on or near the two Santa Barbara Channel Islands, Santa Cruz and Santa Rosa (Figure 8), present severe conflicts with the policies of the California Coastal Act of 1976. The Nature Conservancy is acquiring most of Santa Cruz Island for preservation of the valuable and unique terrestrial and marine life on the lightly disturbed island. All the islands are used by sensitive sea birds and marine mammals whose breeding and living would be seriously impacted by the noise, ship activity, construction activity and other aspects of an LNG terminal even 3 miles from shore. The waters around the islands are designated an Area of Special Biological Significance by the State Water Resources Control Board and are under study for designation as a National Marine Sanctuary. The islands are proposed for national park status. In addition to these serious disadvantages, the Santa Barbara Channel Island sites present severe geotechnical and other engineering problems both for terminal construction and for the required long underwater gas pipeline to shore.

Only a small part of the Off Chinese Harbor site area (Figure 9) just inside 3 miles from the Santa Cruz Island shore can be considered barely acceptable. A floating type terminal appears to be feasible at this site, but it should only be considered if added remoteness from urban areas is required. The site is about 24 miles across the Santa Barbara Channel from Ventura. An underwater gas pipeline from the site to shore would have to be laid from special barges in water as deep as 770 feet. This depth plus possibly unfavorable bottom currents and other conditions could pose serious problems to pipeline construction and reliability.

Offshore Camp Pendleton

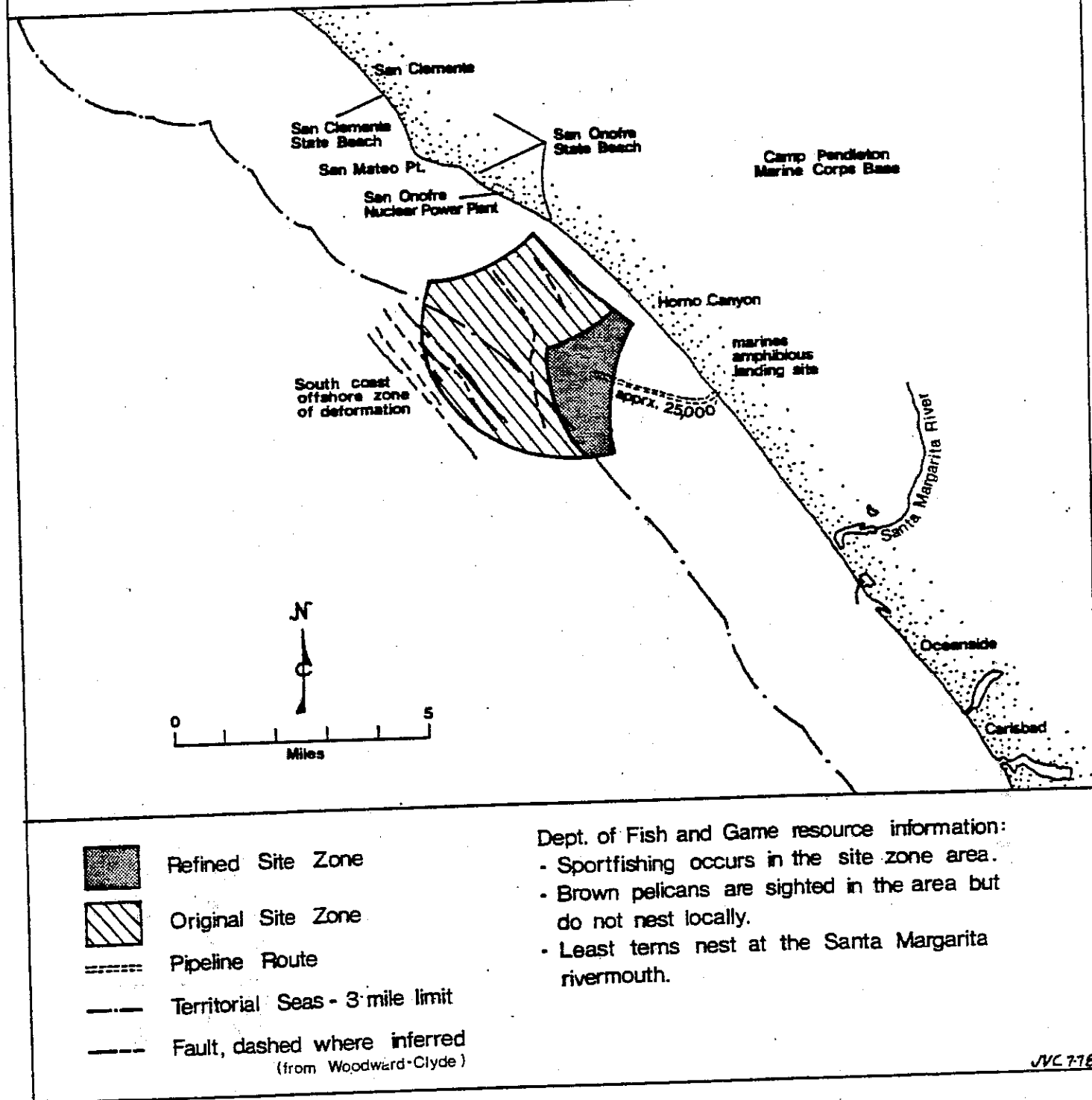


Figure 7

Site Investigation Zones

Channel Islands Area

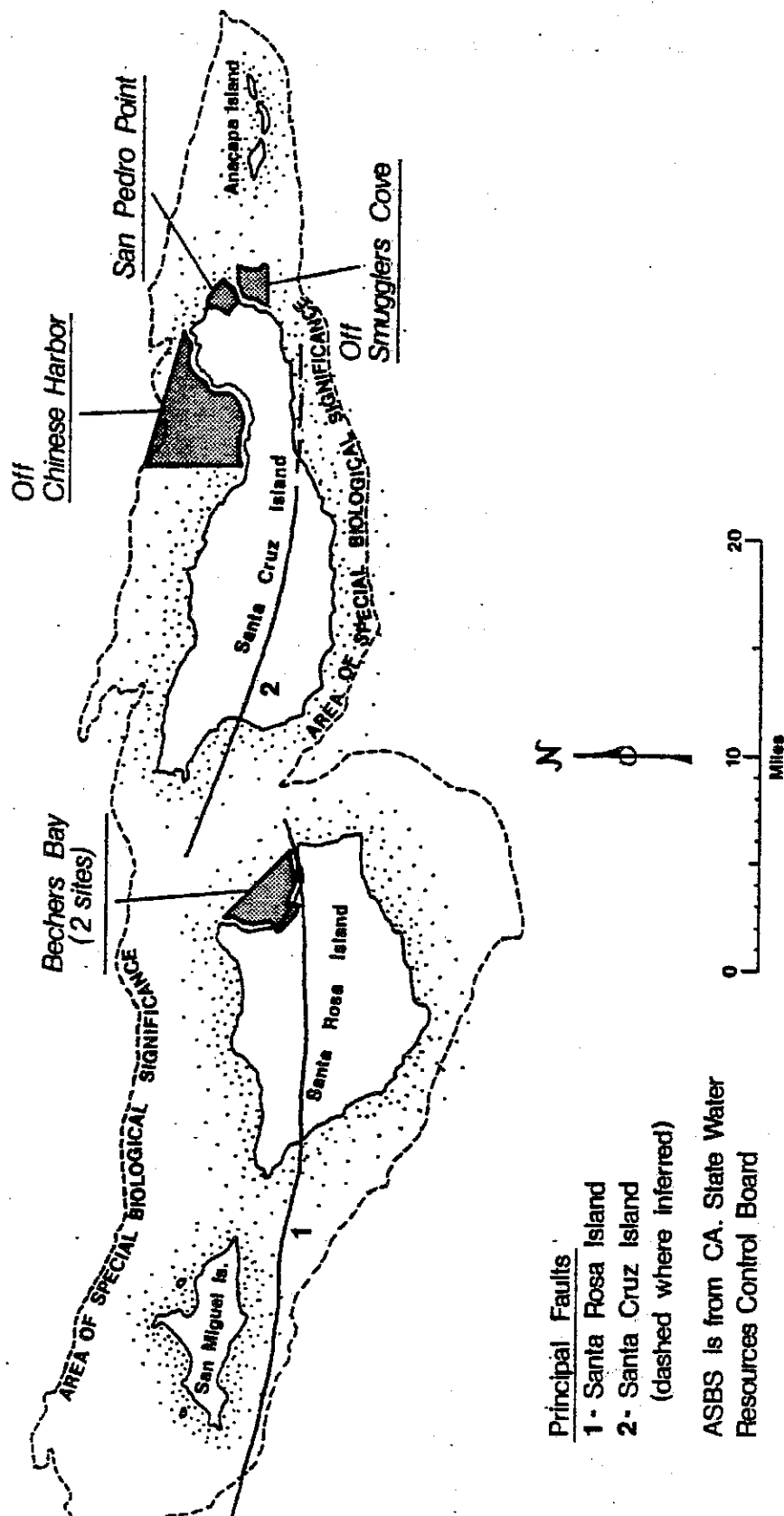


Figure 8

Offshore Chinese Harbor

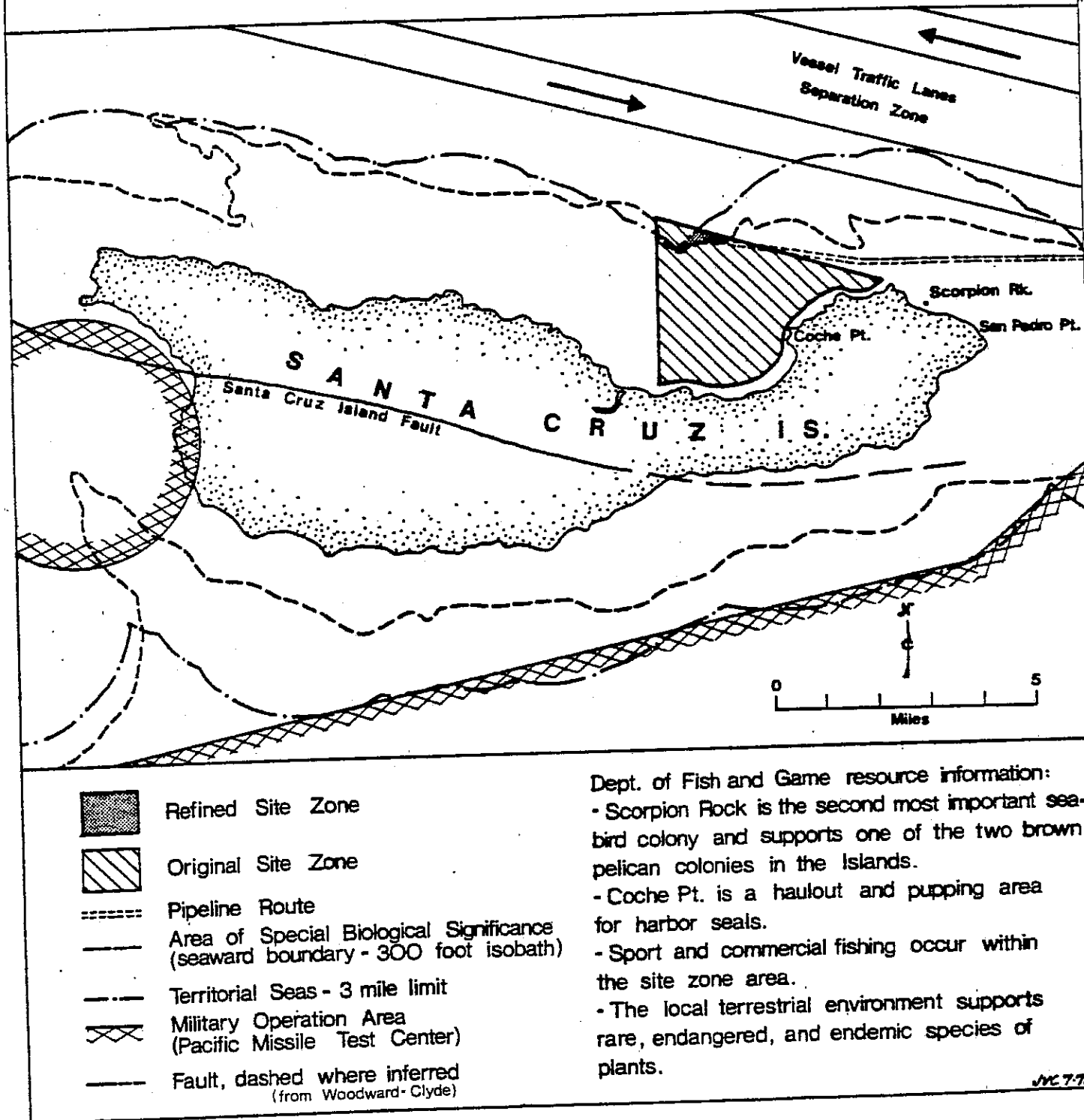


Figure 9

I. BACKGROUND

A. The Liquefied Natural Gas Terminal Act of 1977

The Liquefied Natural Gas (LNG) Terminal Act of 1977 requires the California Coastal Commission to evaluate potential LNG terminal sites which are off-shore from the California mainland, and to submit a final report by September 16, 1978 to the Governor, the Legislature, the Public Utilities Commission (PUC), and the Energy Commission. Section 5650 of the Act states in part:

" . . . the coastal commission shall complete a final study of potential offshore sites and types of terminals for such sites. Such study shall indicate the most appropriate offshore terminal site or sites, in the coastal commission's judgment, together with the most appropriate type or types of terminals for each such site."

The LNG Terminal Act does not establish a procedure for, or authorize, the granting of a permit to construct and operate an offshore LNG terminal. The Act states that California's first LNG terminal, if permitted by the PUC, shall be on the California mainland. The Coastal Commission recently completed an evaluation and ranking of potential onshore sites and submitted a final report to the PUC, as required by the Act, on May 31, 1978.¹

During the 1977 legislative deliberations on the LNG Terminal Act, a number of parties raised the possibility that an offshore terminal might have significant advantages over an onshore terminal. The potential advantages cited include decreased safety risks to onshore populations, minimization of conflicts with residential and recreational use of the coast, and decreased adverse environmental impacts. Prior studies had concluded an offshore LNG terminal would be technically feasible but could take a number of years longer to put

¹ Copies of the Final Report Evaluating and Ranking Onshore LNG Terminal Sites, adopted by the Coastal Commission May 24, are available from the Commission's San Francisco office.

into operation than an onshore terminal.² There was no time during the deliberations, however, to develop detailed assessments of locating an LNG terminal offshore, and therefore the legislation established a procedure for reaching a decision on a permit for a mainland onshore site by July 31, 1978 and for a Coastal Commission study of offshore alternatives.

The Coastal Commission's final offshore LNG report could be used to guide the siting of a second LNG terminal in California, or, if the PUC determines an LNG terminal is not needed until the late 1980s, to assist selection of the most appropriate site from both onshore and offshore alternatives. In order for California's first LNG terminal to be located offshore, however, the LNG Terminal Act would have to be amended by the Legislature.

B. Description of Possible Offshore Terminal Facilities

Background

While there are many operating onshore LNG receiving terminals throughout the world, and presently two in the United States, no offshore LNG terminals have yet been constructed, except on islands. One terminal is being built on Elba Island in the Savannah River, Georgia, while an LNG receiving terminal is operating on the man-made Canvey Island close to shore in the English Channel. From experience with the existing onshore terminals and similar energy facilities designed primarily for oil development, several possible designs for offshore LNG terminals have been proposed by major engineering companies. These include terminals floating on the water and anchored to the ocean floor and terminals supported by the ocean bottom. Regardless of terminal design, however, any offshore terminal would perform the same function as terminals located onshore: to receive LNG transported by ships, unload and transfer the LNG into storage tanks, regasify it, and deliver natural gas via underwater pipelines to California's gas transmission system. Because cryogenic pipelines able to carry LNG at -260° cannot be built more than a few miles long without serious heat gain problems, an offshore terminal would have to send the regasified LNG to shore as natural gas, so all terminal functions, including LNG storage and regasification, would have to take place at the offshore terminal. With a mainland onshore terminal,

² Fairchild Stratos Division, Offshore LNG Receiving Terminal Project, 3 volumes and supplement to volume 2, prepared for Western LNG Terminal Company, Manhattan Beach 1977. Report No. 4-76153. See also:

Atlantis Scientific, Feasibility Study: Offshore Siting of LNG Facilities, 1976.

Marcus, Henry S. and John H. Larson, Offshore Liquefied Natural Gas Terminals, prepared for the U.S. Department of Transportation Center for Transportation Studies, M.I.T., Cambridge, October, 1977.

R and D Associates, Offshore LNG Terminal Study, prepared for Western LNG Terminal Company, Los Angeles, 1976.

the LNG is unloaded from a tanker at the end of a trestle and transferred in a short cryogenic pipeline to storage on land until it is regasified and delivered to the gas transmission system (Figure I-1).

C. LNG Terminal Components and Performance Requirements for This Study

The LNG terminal evaluated here has the same general facilities and performance as the terminal proposed by Western LNG Terminal Associates for the Little Cojo site near Point Conception.

LNG Unloading. Once the LNG tanker has moored beside the terminal, the LNG will be transferred to the terminal's storage tanks. This study has assumed the tanks would have a capacity similar to the onshore terminal proposed by Western LNG Terminal Associates or about 1.65 million barrels. This is approximately equal to the LNG carried by two of the largest existing LNG tankers. The insulated storage tanks will keep the LNG at its normal liquefied temperature of -260°F .

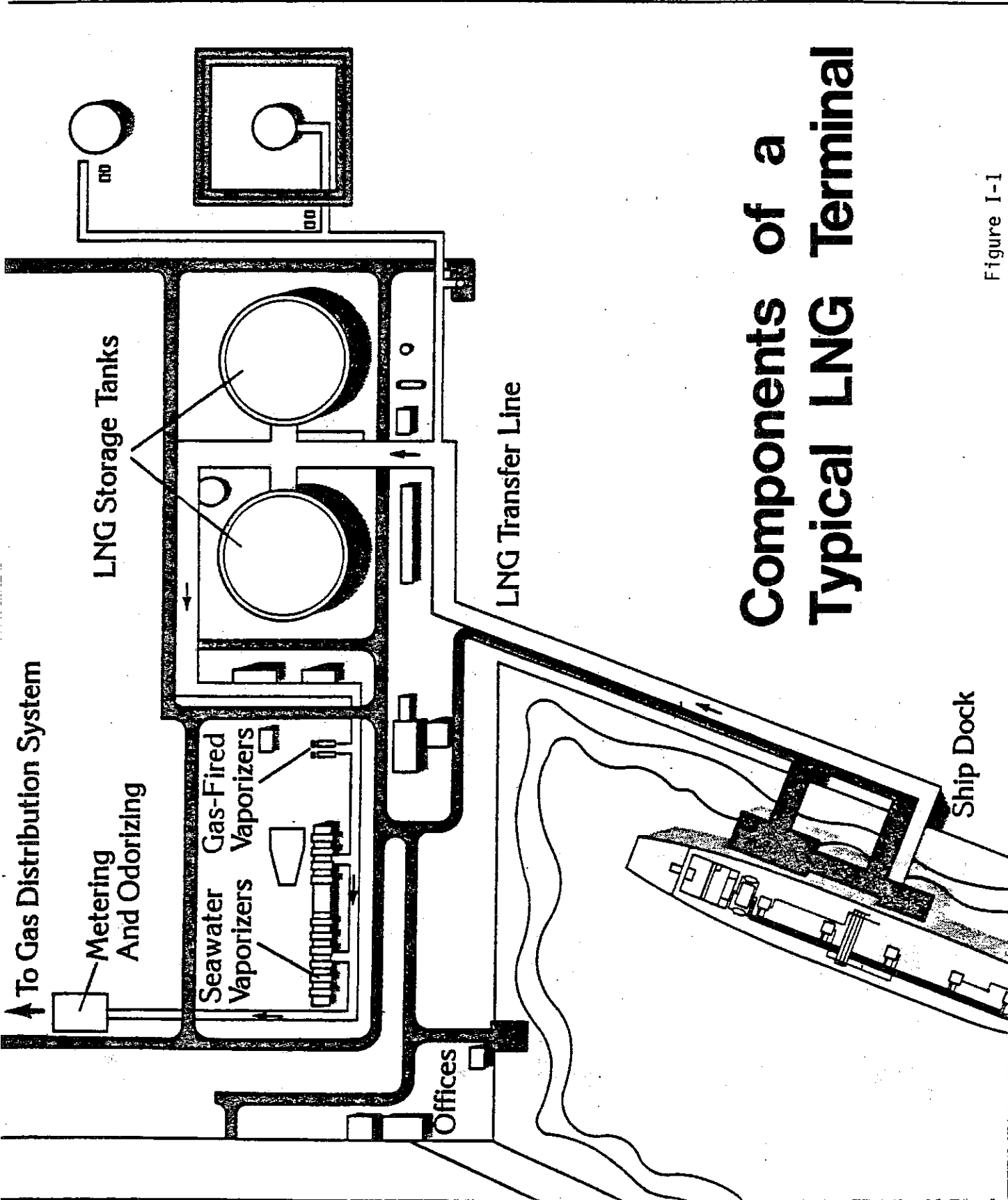
LNG Gasification (Vaporization). Before entering the natural gas transmission system for distribution, the LNG must be gasified and warmed to at least 40°F . The LNG is pumped from the storage tanks and revaporized in a heat exchange chamber using seawater or burning gas as the heat source. Under full operation 1.3 billion cubic feet per day (BCFD) of natural gas will be vaporized.

Seawater System. Seawater to vaporize the LNG is pumped from the ocean at a rate of about 100,000 to 200,000 gallons per minute. After warming the LNG the cooled seawater is returned to the ocean at a temperature about 10° to 12°F lower than at intake. Some form of biocide may be required to prevent marine growth in the seawater system.

Natural Gas Pipeline. Once the LNG has been pressurized, the natural gas is gasified and sent into two parallel underwater natural gas transmission lines. Except where special protection is needed, the pipelines would be on the surface of the ocean floor until they approached the surf zone of the shore, where they would be buried by several feet of cover. The pipelines would remain underground until reaching the most feasible point of connection to California's main gas distribution pipelines. The offshore pipeline distances from evaluated offshore sites vary from 1 to 60 miles, and the onland pipeline distances from shore to the distribution lines vary from 30 to 100 miles.

Bunker C Fuel Oil. Bunker fuel oil for LNG vessels will be brought to the terminal by tanker ship or barge and will be pumped into an oil storage tank. The number of bunker fuel deliveries needed will depend on the capacity of the storage, but approximately four shipments a month are estimated.

Electric Power. Electric power is needed at the terminal to operate the pumps for the seawater system, the LNG unloading process and natural gas send-out, as well as for normal low-voltage power needs. Electricity can be imported by cable to sites near shore or generated by natural gas turbines run with the terminal's vaporized LNG.



Other Storage. The terminal will store and transfer diesel fuel, fresh water, liquid nitrogen, provisions, and sanitary waste to LNG ships or service barges.

Operating Personnel. The terminal would require an operational work force of 50-75 employees, who will either live in quarters at the facility or commute by boat.

Tug Boats. Arriving LNG tankers will probably require assistance from tugs when making their approach to the terminal. Tugs would probably be based at a mainland California port and steam to the terminal when tankers are due to arrive.

Terminal Design Alternatives

Since no offshore facility has yet been built at an open ocean site, no one design has been universally accepted as the most feasible, reliable or economical. To evaluate and review various possible terminal concepts, the Commission contracted with three terminal design-construction firms for illustrative design work with estimates of construction cost and timing. The three illustrative terminal designs represent the three major structural approaches possible for offshore energy facilities at ocean (not island) sites: floating terminals, bottom-supported terminals in which the storage tanks extend above the water surface, and subsea bottom-supported terminals in which the tanks are completely under water. The final design could combine desirable features of more than one type studied.

D. Previous Commission Actions and Study Approach

In October 1977 the Commission directed the staff to begin an evaluation of possible offshore LNG terminal sites and of different terminal concepts. The basic study approach was to (1) identify major types of offshore LNG terminal designs and their siting requirements; (2) apply those siting requirements to the California offshore area to identify possible suitable siting areas; (3) develop performance standards and criteria for offshore LNG terminals; (4) contract for site-specific illustrative designs of three different types of offshore LNG terminals; (5) evaluate those designs with respect to the standards and criteria; (6) evaluate and judge the remaining suitable siting areas and the types of terminals that could feasibly be placed on them; and (7) assess the time needed for approval of offshore LNG terminals by presenting the site-specific illustrative designs to regulatory agencies for their reactions. This approach and the initial identification of terminal siting requirements and offshore California areas that might be suitable for LNG terminals were presented in the February 1, 1978 staff report, "California Offshore LNG Terminal Study, Interim Report."

To manage and support this special study, the Commission contracted with the consulting firm of Rust and Weinstein, Inc. of San Francisco, with Ted Rust as project manager. The Commission also retained consultants to evaluate the site areas: John J. McMullen Associates in Oxnard for evaluating maritime factors including wind and wave conditions and navigational hazards; Woodward-Clyde Consultants in Orange for geotechnical evaluations; H. J. Degenkolb and Associates

for structural engineering analysis; the California Department of Fish and Game for identification of marine and terrestrial plant and wildlife resources; Madrone Associates for analysis of terminal impacts on natural resources; the U.S. Army Corps of Engineers Waterways Experiment Station for wave calculations; and PBQ&D, Inc. for pipeline routes and feasibility; and Alan Magary for editorial consultation. The site conditions are analyzed in Section III, and the supporting consultant reports are summarized in Appendices A through D.

To enable site-specific evaluations of actual LNG terminal designs, the Commission contracted with three design-construction firms for illustrative designs of three different terminal types at three sites. General Dynamics was selected to develop design work for its floating barge terminal concept; Preload-Dravo for its concrete, shallow-water bottom-supported concept; and Norwegian Contractors for its concrete, deep-water bottom-supported concept called "Condeep." These three designs were selected after reviewing proposals from twelve firms. The design studies are evaluated in Section IV and summarized in Appendices G, H, and I.

Since there are no state or federal design standards for offshore LNG terminals, the Commission staff and consultants developed preliminary design criteria, relying heavily on existing standards for other offshore facilities such as ships and oil platforms, but raising the required level of overall safety to one more appropriate for such a large, critical, and potentially hazardous facility. The Commission's consultants in this area, who also helped evaluate the design studies, included Wesson and Associates for safety and fire prevention design criteria; John J. McMullen Associates in New York for maritime and LNG systems criteria; Woodward-Clyde Consultants in Houston for seismic design criteria; PBQ&D, Inc., for critical review of LNG terminal cost studies; Dr. Ben Gerwick, Jr., for structural design criteria; and Maurice V. Scherb for general technical review. These criteria, presented in Appendix F, are recommended as a point of departure for future regulation of LNG terminal design.

The following section presents the terminal and site evaluations and the major conclusions, while Section III provides information and evaluation of the offshore terminal siting zones that were identified in February 1978. Section IV evaluates the three different types of offshore LNG terminals and evaluates their advantages and disadvantages. The regulatory requirements for approval of an offshore LNG terminal at the different sites and the approval prospects, including expected time to terminal operation, are discussed in Section V.

The staff work on this project was done by Brian Baird, Dona Gara, Chris Garland, John Grattan, Bill Johnson, Jody Loeffler, Suzanne Rogalin, Tom Tobin, and Jonathan Van Coops, under the general direction of Energy Coordinator William Ahern.

II. SITE AND TERMINAL EVALUATIONS AND CONCLUSIONS

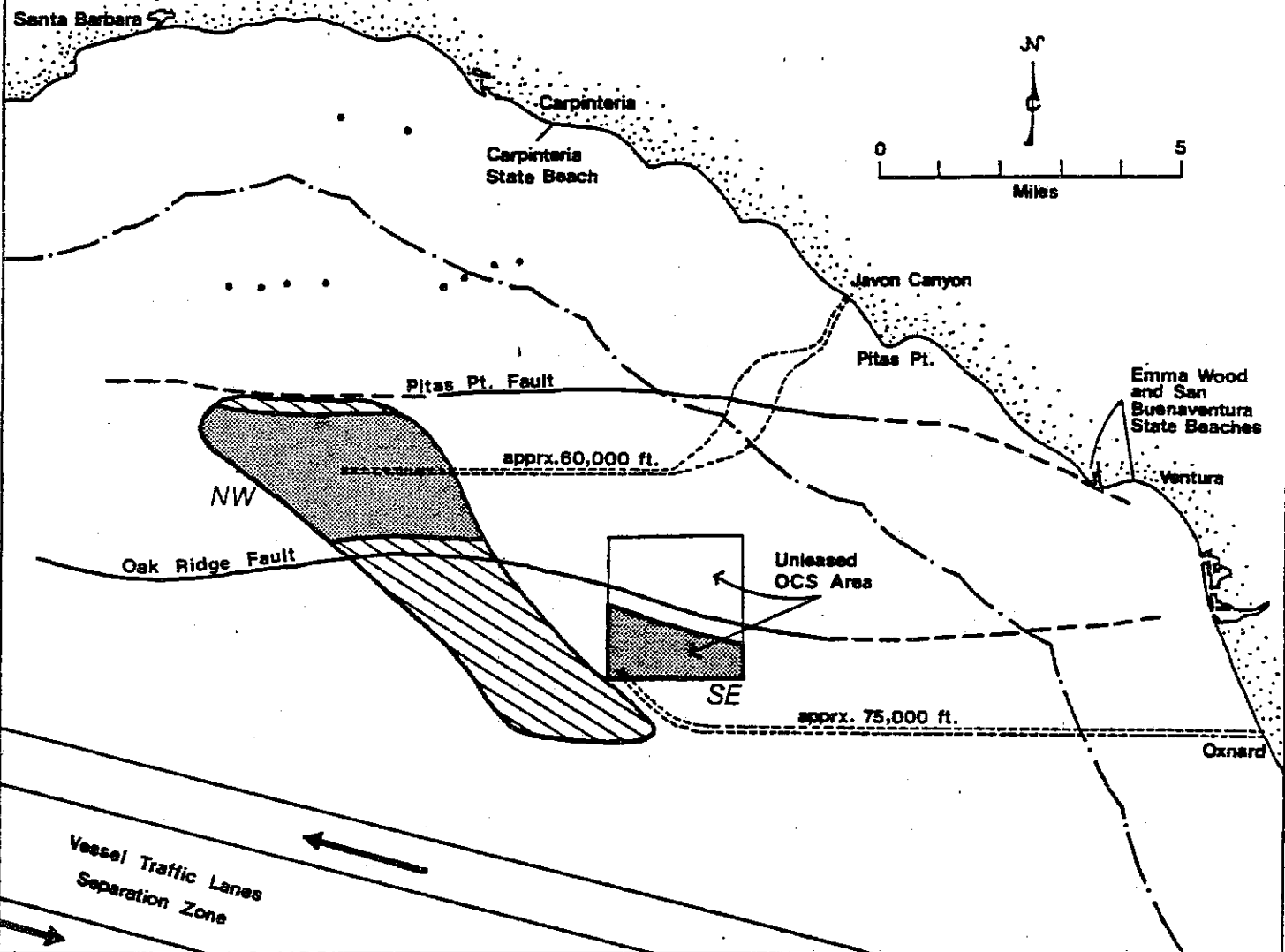
A. Major Conclusions

The most appropriate offshore LNG terminal siting area is the southeast part of the Ventura Flats zone, 12 miles southwest of Ventura in the eastern Santa Barbara Channel, with an underwater pipeline landfall at Oxnard (Figure II-1). A floating type LNG terminal could feasibly be placed in this siting area, but the feasibility of a bottom-supported design there has not been demonstrated. A floating terminal on this site would have small to moderate adverse impacts on marine and coastal resources, but these would be less severe than at any other offshore site investigated by the Coastal Commission. The total construction cost in 1978 dollars of an LNG terminal on southeast Ventura Flats, with connecting subsea and overland pipelines, would cost between \$400 and \$600 million. If there were strong political, financial and technical support, a terminal there could be in operation in as little as six years from the decision to prepare an application. However, any strong opposition or unforeseen technical problems could stretch the approval process many years, since numerous safety, energy, and environmental agencies would have to grant approvals, and both new federal and state legislation would be needed to enable overall terminal approval. The terminal site is on the federally owned outer continental shelf beyond the state's three mile from shore jurisdiction.

Three other siting zones are feasible and acceptable for siting an offshore LNG terminal, but each is substantially less appropriate than Ventura Flats. These three are: 1½-3 miles offshore Camp Pendleton, one mile off Deer Canyon in Ventura County, and approximately three miles offshore Chinese Harbor at Santa Cruz Island (Figure II-2). Other potential siting areas near and on the Santa Barbara Channel Islands are unacceptable. In general, the two zones within three miles of the mainland, off Camp Pendleton and off Deer Canyon, present serious conflicts with recreational and military use of coastal areas. The zones near the Santa Barbara Channel Islands have the substantial disadvantage of being near the valuable and sensitive marine mammal and sea bird breeding areas on these relatively undisturbed islands. They are also difficult to reach with a subsea gas pipeline from shore due to the deep water and severe bottom conditions in the Channel.

The floating type of LNG terminal can be sited at all four acceptable siting zones because its feasibility and approval do not depend strongly on favorable seismic and sea bottom conditions. Only the base of the mooring system for a floating terminal is supported by and attached to the sea bottom (Figure II-2). While this is a critical element of the terminal, it represents only 2% of its cost and can be repaired if damaged by earthquake shaking or subsea landslides or other forces. The floating terminal itself would be supported by the water, and the water surface conditions are generally benign in the site areas that were selected.

Ventura Flats



Refined Site Zone



Original Site Zone



Pipeline Route



Territorial Seas - 3 mile limit



Oil Drilling Platforms



Fault, dashed where inferred
(from Woodward-Clyde)

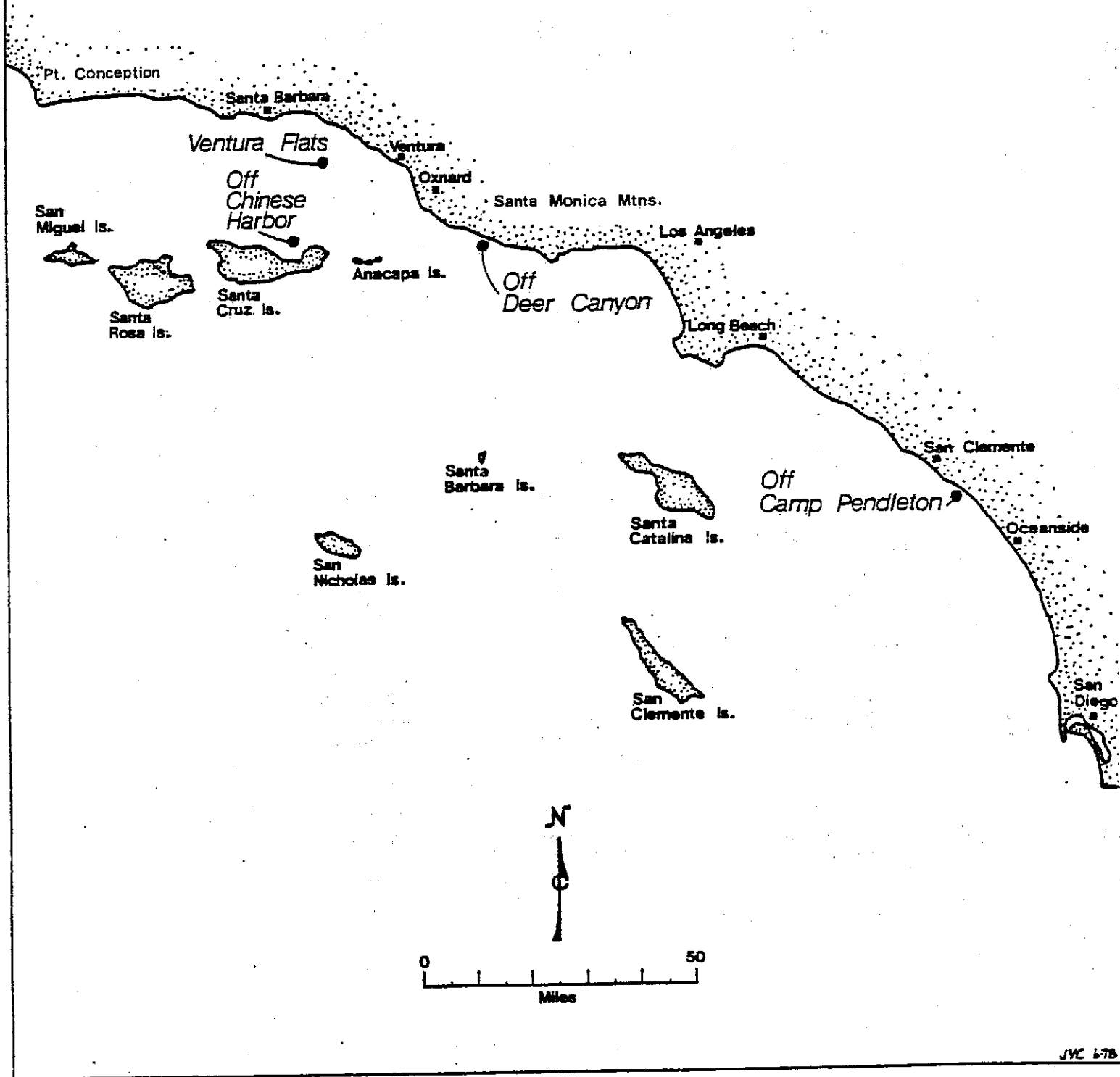
Dept. of Fish and Game resource information:

- Ventura Flats is heavily fished by purse seiners which make significant catches of northern anchovies.
- Brown pelicans and harbor seals feed in the site zone area.
- Grey whales pass through the site zone area during their migration period.

JVC 7-7B

Figure II-1

Acceptable Offshore LNG Terminal Sites



JVC 678

Figure II-2

On the other hand, sea bottom characteristics for supporting large critical facilities off California are generally demanding. The continental shelf is criss-crossed by numerous known and unknown earthquake faults (Figure 5). Much of the sea bottom is steep with unstable slopes. While initial evaluations indicate the shallow water bottom-supported type terminal may be feasible off Camp Pendleton and the deep water bottom-supported type on northwest Ventura Flats and off Chinese Harbor, there would be uncertainty about geotechnical feasibility and regulatory approvals, until an applicant has conducted extensive site and design-specific geotechnical evaluations and carried the burden of proof that a bottom-supported terminal could be safely and reliably built and operated.

The bottom-supported type offshore terminal should not be removed from further consideration, however, because it presents some advantages over the floating type. With floating terminals, both the terminal and the LNG tanker would move in response to wind and waves, creating large relative motions that could make LNG tanker berthing and unloading difficult. In addition, because a floating terminal would experience vertical and horizontal motions in the water, the gas pipeline to the sea bottom would have to swivel. While these motions can be accommodated in floating terminal designs, the bottom-supported type terminal provides a stable unloading berth for tankers and a rigid pipeline connection to the seafloor, enabling greater simplicity and reliability in the terminal system.

B. Initial Site Selection

Selection of feasible sites for an offshore LNG terminal has been just as difficult as locating possible onshore terminal sites. The most difficult siting constraint results from the need to connect any offshore terminal to the mainland with a large, high-pressure gas transmission pipeline. Such a pipeline can be installed reliably in ocean depths only to about 750 feet and, as shown in Figure II-3, this limit prevents use of most waters more than a few miles offshore. It also requires fairly gentle bottom topography. The offshore southern California bathymetry contains many basins as deep as 3,000 feet and much rugged terrain. A second major siting constraint is the generally hostile wind, wave and swell environment at offshore areas north of Point Conception. Wind, waves and fog can be frequent and severe off much of the coast, making marine operations more hazardous and less reliable. Applying the technical constraints of wind and wave conditions, areas offshore central and northern California between Point Conception and the Oregon border were eliminated from serious consideration. In addition, military operations, ship traffic, the presence of valuable marine and coastal resources and other factors limit the number of California offshore areas where a terminal could be built.

Offshore LNG Terminal Siting Constraints

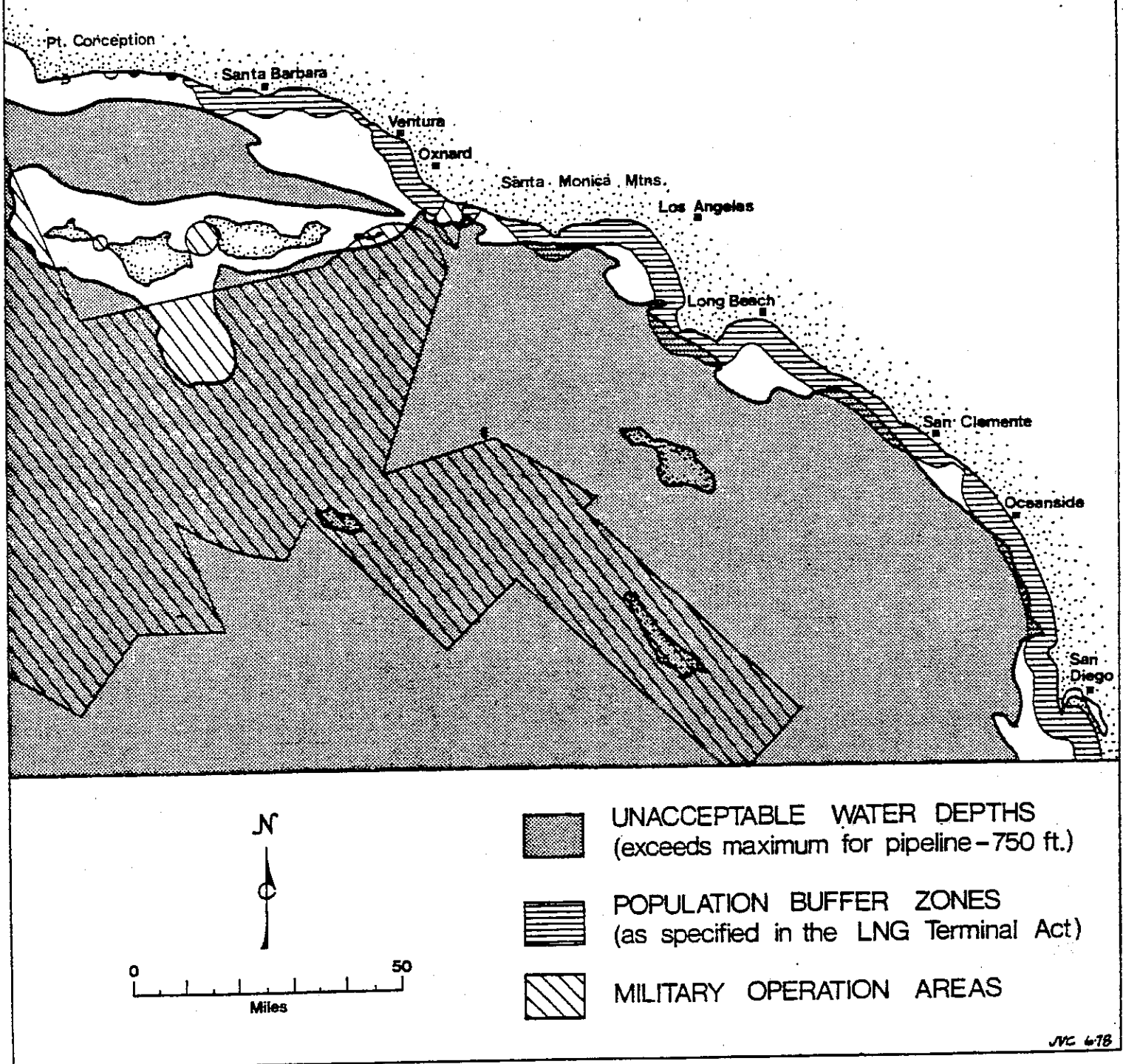


Figure II-3

The limitation on ocean depths greater than 750 feet eliminates virtually all of the offshore area more than five miles from the mainland coast, with the exception of the Santa Barbara Channel Islands.¹ The islands are "linked" to the mainland by ocean depths of about 750 feet across the eastern end of the Channel. This connection is present because the Channel Islands are the underwater extension of the onshore Santa Monica Mountains range.

Although the LNG Terminal Act establishes population density requirements for the siting of an onshore LNG terminal to ensure a remote site, no guidance was given on population criteria for possible offshore sites. Siting an offshore facility closer to populated areas than allowed for onshore sites, however, would be inconsistent with legislative intent. Therefore, those offshore areas within four miles of about 1,800 permanent residents or workers were eliminated from consideration.

Military operations pose some potential problems to siting an offshore LNG terminal. Hundreds of square miles immediately south of the Channel Islands and two areas in the island chain are within the critical test ranges of the U.S. Navy's Point Mugu Pacific Missile Test Center. Possible sites off the southern part of the Channel Islands were dropped from serious consideration because of this conflict and the availability of other sites elsewhere around the islands.

As shown in Figure II-4, only a few offshore areas remain as feasible locations after these major siting constraints are applied. Three areas, offshore from Los Angeles, Long Beach and San Diego, were eliminated from further consideration due to the large population concentrations just beyond four miles and the vessel traffic in the area. From the remaining feasible areas, seven site "zones" were selected for extensive review by staff and consultants. Zones, as opposed to specific sites, were chosen to allow for flexibility in future siting after detailed evaluation of bottom conditions, seismic characteristics, possible terminal designs, and other factors. The seven site zones selected were:

<u>Zones</u>	<u>Facility Types Considered</u>
(1) Ventura Flats, eastern Santa Barbara Channel	Floating, Subsea Bottom-Supported
(2) Off Deer Canyon, Ventura County	Floating

¹ Deeper pipelaying techniques are being developed. The same basic siting constraints would apply, however, even if this limit were doubled.

<u>Zones</u>	<u>Facility Types Considered</u>
(3) Off Camp Pendleton San Diego County	Floating, Shallow Bottom-Supported
(4) Smugglers Cove, off Santa Cruz Island	Floating, Shallow Bottom-Supported
(5) San Pedro Point, on Santa Cruz Island	On-island
(6) Chinese Harbor, off Santa Cruz Island	Floating, Shallow and Subsea Bottom-Supported
(7) Bechers Bay, Santa Rosa Island	Floating, Shallow Bottom-Supported, On-island

Parts of the nearshore area off Santa Barbara County, both off Pitas Point and at the western end of the Channel also meet the population and wind and wave requirements. But these offshore sites within three miles of shore were not retained for further evaluation early in this year because there appeared to be at least two feasible onshore sites for an LNG terminal, Little Cojo and Las Varas. There seemed to be no advantage in siting a nearshore terminal in the water, where onshore sites were available and appeared more desirable. However, now that seismic problems have eliminated Las Varas and affected approvability of the Little Cojo onshore site, there could be advantages with a floating terminal since it would be decoupled from the most serious seismic forces. On the other hand, any offshore LNG terminal near the mainland in the western Santa Barbara Channel would conflict with the valuable marine and recreational resources present there.

C. Evaluation of Sites and Terminals

The basis for the conclusions is the evaluation of 16 site and terminal type combinations with respect to engineering feasibility, public safety, conflicts with current uses of offshore areas, adverse environmental impacts, cost, and time expected for approvals and construction. In ranking possible onshore LNG terminal sites, the Coastal Commission was required to base its ranking on the policies and goals of the California Coastal Act of 1976. In applying these policies the Commission gave heavy weight to policies protecting public access and recreation along the coast, marine and terrestrial natural resources, and the unique and scenic character of remote coastal areas. The Commission also considered public safety and terminal cost in the ranking. Sites such as the Las Varas site were removed from the ranking when information on seismic

Offshore LNG Terminal Sites

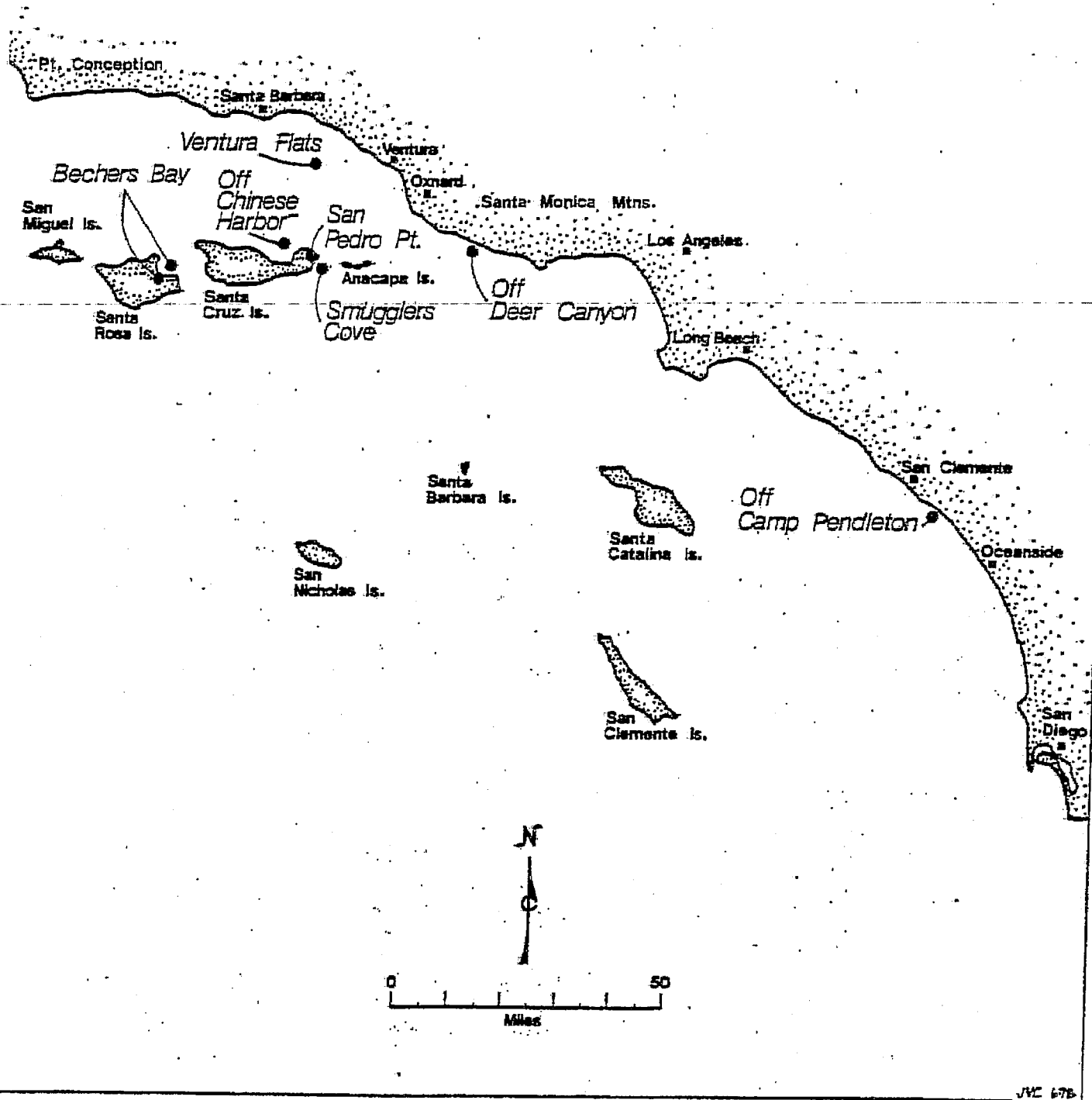


Figure II-4

conditions brought the feasibility of constructing a terminal into serious question.

In this consideration of offshore LNG terminal sites, the Commission is conducting a study and providing a judgment on "...the most appropriate offshore terminal site or sites. . .together with the most appropriate type or types of terminals for each such site" (Public Resources Code, Section 5650). Since a decision is not imminent on siting an offshore terminal, bottom-supported terminals on sites are evaluated for feasibility but are not removed from consideration if clear geotechnical acceptability has not been proven. Added evaluations by an applicant may demonstrate their feasibility on some sites. Another evaluation factor not considered in the onshore LNG terminal site ranking was the timing of terminal operations after the decision to pursue an application. That factor has been considered by the Public Utilities Commission in its assessment of the Western LNG Terminal Associates' application, but was explicitly excluded from the Coastal Commission's site ranking. In this study the timing issue is an important factor in site and terminal evaluation because a site and terminal can be considered "more appropriate" the sooner it could be put into operation and the less opposition and uncertainty surrounds required legislation and agency approvals. These evaluation factors are listed in Table 1 and are discussed in more detail below, along with evaluations of 16 site and facility type combinations.

Confidence in Construction Feasibility With Respect to Geotechnical Factors

It has proven difficult to have high confidence in any California onshore or sea bottom-supported LNG terminal site subject to possible forces from earthquakes that occur frequently over a wide area where the Pacific and North American tectonic plates are moving in relation to one another. Faults discovered after construction of nuclear power plants at Humboldt Bay, Diablo Canyon and Vallecitos have halted or jeopardized operations of those critical facilities. The Commission discovered a small but active fault on the Las Varas onshore site in Santa Barbara County only after trenching. Uncertainties about faults now affect possible approvability of the Little Cojo site near Point Conception that has had millions of dollars of seismic evaluations. Offshore underwater seismic and soils evaluations are more difficult and uncertain than onshore because of intervening water depths.

Consequently, high confidence in terminal feasibility and ability to obtain needed approvals related to seismic safety is warranted only for the floating type terminal, which is mostly decoupled from seismic forces. Off Camp Pendleton fault traces are evidently present (Figure II-5), although Commission consultants indicate an acceptable site for a shallow water bottom-supported terminal can probably be found, warranting medium confidence at this preliminary stage of seismic evaluation. The same medium confidence applies to a possible deep water bottom-supported site on northwest Ventura Flats. All other sites for bottom-supported terminals merit low confidence.

TABLE 1: Summary of Site Evaluations

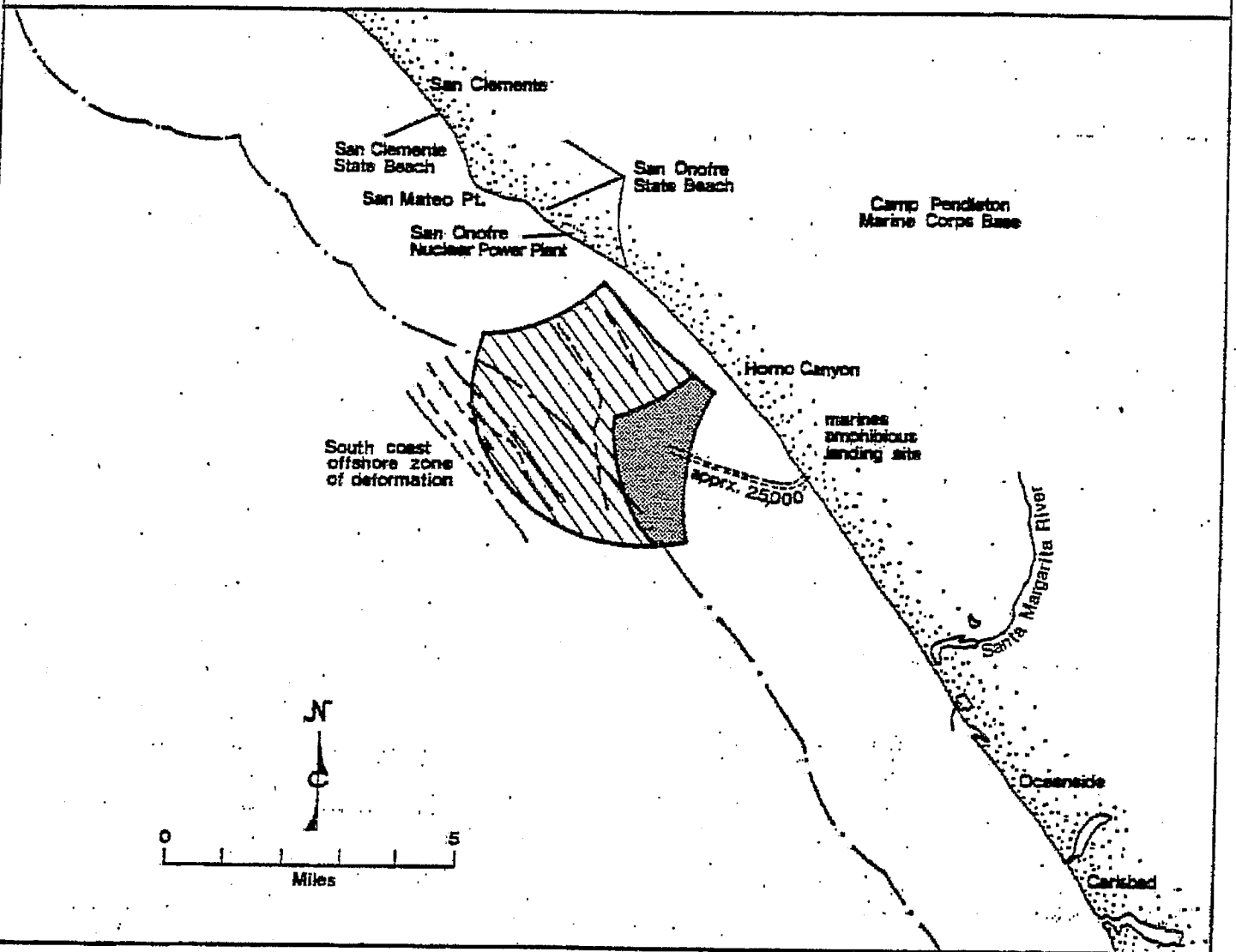
	Ventura Flats SE		Ventura Flats NW		Off Deer Canyon	Off Camp Pendleton	
	Floating Subsea		Floating Subsea		Floating	Floating Shallow Bottom	
<u>Confidence in Construction Feasibility With Respect to Geotechnical (Mainly Seismic) Factors</u>							
--Terminal	High	Low	High	Medium	High	High	Medium
--Pipeline	High	High	High	High	Low	High	High
<u>Confidence in Reliability of Operations</u>							
--Berthing (weather)	92%	96%	92%	96%	97%	98%	94%
--Pipeline (seismic)	High	High	Medium	Medium	High	High	High
<u>Public Safety</u>							
--Distance to nearest 1,000 people	12 mi	12 mi	9 mi	9 mi	4-6 mi	7 mi	5.5 mi
--Activity nearby (3 mi)	Sparse	Sparse	Sparse	Sparse	Moderate	Intense	Intense
--Critical facilities	None	None	None	None	Pt. Mugu, 4 mi	San Onofre Nuclear Power Plant, 4 mi	
<u>Use Conflicts</u>							
--Recreational conflicts	None	None	None	None	Substantial	Moderate	Substantial
--Petroleum leases	None	Leased	Leased	Leased	Partly	None	None
--Military conflicts	None	None	None	None	Small	Substantial	
<u>Adverse Marine and Coastal Resource Impacts</u>							
--Fishing	Moderate		Moderate		Moderate	Small	Small
--Special species	Some disturbance		Some disturbance		Some dis.	Small	Small
--Compatibility	Acceptable		Acceptable		Very poor	Poor	Poor
--Construction	Small	Small	Small	Small	Small	Small	Substantial
--Onshore pipeline	Small	Small	Severe	Severe	Substantial	Small	Small
Cost, \pm 20% (1977-78 dollars)	\$489m	\$552m	\$507m	\$570m	\$454m	\$414m	\$431m
<u>Timing to Operation</u>							
--Minimum time to operation	6-7 yr	7-8 yr	6-7 yr	7-8 yr	6½ yr	6½ yr	8 yr
--Likely opposition	Moderate		Substantial		Severe	Extreme	Extreme
Preliminary Overall Judgment	Most appropriate	Appropriate if feasible	Less appropriate	Less appropriate	Less appropriate	Less appropriate	Less appropriate



Box represents serious constraint

Off Chinese Harbor		Off Smugglers Cove		On San Pedro Point	Off Bechers Bay		Onshore Bechers Bay
Floating	Subsea	Floating	Shallow Bottom		Floating	Shallow Bottom	
High	Low	High	Low	Low	High	Low	Low
Probable, but not demonstrated					Questionable		
96%	97%	97%	96%	96%	94%	95%	95%
Medium	Medium	Medium	Medium	Medium	Low	Low	Low
24 mi	24 mi	23 mi	23 mi	21 mi	30 mi	30 mi	30 mi
Sparse	Sparse	Moderate	Moderate	Moderate	Sparse	Sparse	Sparse
None	None	None	None	None	None	None	None
Moderate	Moderate	Severe	Severe	Severe	Substantial		Substantial
None	None	None	None	None	None	None	None
Small	Small	Substantial		None	Substantial		Substantial
Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe
Substantial		Severe	Severe	Severe	Severe	Severe	Severe
Very Poor		Unacceptable		Unacceptable	Unacceptable		Unacceptable
Small	Small	Small	Substantial	Severe	Small	Substantial	Severe
Small	Small	Small	Small	Small	Small	Small	Small
\$565	\$628	\$524	\$545		\$659	\$680	
6 1/2 yr	7 yr	No realistic figure					
Severe	Severe	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Barely acceptable		Not acceptable		Not acceptable	Not acceptable		Not acceptable

Offshore Camp Pendleton



Refined Site Zone



Original Site Zone



Pipeline Route



Territorial Seas - 3 mile limit



Fault, dashed where inferred
(from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Sportfishing occurs in the site zone area.
- Brown pelicans are sighted in the area but do not nest locally.
- Least terns nest at the Santa Margarita rivermouth.

JVC 778

Figure II-5

The geotechnical factors are somewhat less critical in constructing and obtaining approval for the subsea gas pipeline to shore because two lines can be used for reliability, and prudent design, routing and construction can minimize risks of rupture due to earthquake shaking and other sea bottom disturbances such as landslides and strong scouring currents. Crossing to the Santa Barbara Channel Islands, however, presents many serious construction problems for a subsea gas pipeline, including: crossing steep and unstable slopes, crossing water depths to 770 feet that strain expected subsea pipeline laying capabilities, and presence of strong bottom currents.

Confidence in Reliability of Operations

The Commission's maritime consultants indicate that the percentage of time during the year an LNG tanker could safely berth at all evaluated sites exceeds 90%. This merits general high confidence in reliability of LNG tanker deliveries. There is a wider difference in the reliability of natural gas pipeline deliveries to shore due to the length of subsea pipelines required and the number and size of faults that must be crossed. The pipeline routes to shore from southeast Ventura Flats and offshore Deer Canyon and Camp Pendleton rate high confidence because they appear not to cross major earthquake faults or unstable slopes. The routes from northwest Ventura Flats cross the Pitas Point Fault. From sites on or near Santa Cruz Island, the routes cross unstable slopes and areas subject to strong bottom currents. The Bechers Bay route also crosses a wide area of active faulting and may be infeasible. These geotechnical factors are discussed in more detail in Section III, and in Appendices A and B.

Public Safety

The major factor affecting public safety would be the distance of a terminal from population concentrations, which is measured here as the distance from a terminal site to the nearest 1,000 people. Distances from urban areas are listed in Section III under specific sites. In general, the sites at the Channel Islands are most remote while the nearshore sites are only 4 to 7 miles from significant numbers of permanent residents and workers. The Ventura Flats area provides a middle ground, 9 to 12 miles from the nearest 1,000 people. The offshore Camp Pendleton area has the added disadvantage of being about four miles from the San Onofre Nuclear Power Plant. This would present a problem to the electric utility owners of that plant, since they would have to prove to the Nuclear Regulatory Commission that the LNG terminal poses an acceptable safety risk to the plant.

Use Conflicts

Potential LNG terminal conflicts with existing uses of offshore areas present two problems: the current use could be damaged or disturbed

and the current users could be expected to oppose terminal approval. A large LNG terminal on or near the Santa Barbara Channel Islands or off existing popular coastal parks would intrude on the recreational experience of boaters, hikers and other visitors to those coastal and offshore areas. The boating and hiking experience at the Channel Islands, including the Channel Islands National Monument at Anacapa Island, is particularly valuable for its remote and unique character. This would be substantially affected by LNG terminal construction and operation. The potential conflict with recreation would be minimal only at Ventura Flats, which is out in open water more than 10 miles from both coastal parks and the sensitive Channel Islands.

Much of the southern California offshore area is under federal or state lease to oil companies for petroleum exploration and development. The Interior Department has already leased the northwest area of Ventura Flats and Texaco is conducting exploratory drilling there. Lease Sale #48 may offer for lease all presently unleased tracts in the Santa Barbara Channel area, although USGS staff indicate that no petroleum field is presently suspected within the recommended SE Ventura Flats zone. The California State Lands Commission has also leased part of the area off Deer Canyon to oil companies. A more serious use conflict would arise off Camp Pendleton where, according to the Navy and Marine Corps, an LNG terminal would seriously interfere with amphibious training exercises needed for national defense preparedness. The Navy also conducts exercises, including mine laying exercises, in the Channel near Bechers Bay between Santa Rosa and Santa Cruz Islands.

Adverse Marine and Coastal Resource Impacts

The potential adverse impacts of LNG terminal construction and operation and of onshore pipeline construction on natural marine and coastal resources are presented in more detail in Section IV on specific sites and in Appendix C. A terminal could affect small fish and plankton by sucking them into the seawater exchange system if one is used, and could restrict commercial and sport fishing through a safety exclusion zone and other interference with fishing boats. Therefore, adverse impacts at a site would be more severe the greater the quantity, diversity and sensitivity of marine life, and the greater the fishing effort there. Consequently, the sites at Santa Cruz and Santa Rosa Islands would see substantial to severe adverse impacts, while off Camp Pendleton impacts would be small due to the lack of significant marine resources there. This comparison also generally applies to impacts on special species of marine life, particularly marine mammals and sea birds such as the California brown pelican.

It is difficult for an LNG terminal, with its massive size and industrial character, to be compatible with any remote coastal or offshore areas. Nevertheless, there are major differences among the sites. Again, because Ventura Flats is a moderate distance from both coastal recreation areas and the valuable habitat of the islands, a terminal there could be considered acceptable and compatible with the offshore petroleum development that has taken place and is likely to continue. The site is seaward of 10 existing offshore oil platforms, and Chevron is applying to construct another platform on the Santa Clara OCS Unit a few miles southeast and seaward of the site. The existing and proposed petroleum developments

in the eastern Santa Barbara Channel on both federal and state offshore lands would prevent a terminal at Ventura Flats from intruding on the scenic qualities of the Channel by itself. At the remote and nearly undeveloped islands an LNG terminal would seriously conflict with the natural surroundings. Only at the Chinese Harbor site, three miles off Santa Cruz Island, would a terminal be marginally acceptable and compatible. A terminal near Deer Canyon would intrude on the recreation-oriented character of the Santa Monica Mountains; one off Camp Pendleton would also intrude, but somewhat less due to the presence of the San Onofre Nuclear Power Plant bisecting San Onofre Beach State Park.

When the Commission was ranking onshore LNG terminal sites, the adverse impacts of construction period transportation, noise, and natural resource disturbance were major evaluation factors. Because both the floating and the deep water sea bottom-supported type terminals would require fabrication at a shipyard with deep water access and large docks, such work would most likely occur largely out-of-state. The finished terminals would be towed to the site and moored or sunk to the bottom. Therefore, most construction activity would be related to the connecting underwater and onshore gas pipelines and to terminal installation. Consequently, compared to an onshore terminal or a shallow water terminal requiring on-site fabrication and a large coastal construction staging area, the adverse environmental impacts of the floating or subsea type terminals would be small. However, the construction of these types of terminals would result in fewer expenditures and jobs in California if built out-of-State.

The onshore pipeline construction can also have widely varying adverse impacts on natural resources due to the different landfalls and coastal and inland routes, shown on the site maps. The most severe impacts would result from construction of large diameter gas pipelines across the Pitas Point area and up sensitive coastal canyons. This was, nevertheless, the apparent best route from the northwest Ventura Flats area offshore. From the offshore Deer Canyon area pipelines would have to follow the narrow Pacific Coast Highway, disrupting travel along it, or angle offshore to a spot between the valuable and sensitive Mugu Lagoon and the Santa Monica Mountains. Adverse impacts on coastal access and recreation and on the marine and bird life of the lagoon could be substantial. For the other sites, the onshore pipeline routes would be comparatively level inland through the Oxnard Plain or northern San Diego County.

Cost

There is not a major difference in total estimated construction cost for the different types of terminals at the different sites. The most costly site/facility combinations are out by the Channel Islands where subsea pipeline costs are high. Costs estimated in 1978 dollars range from about \$400 million nearshore off Camp Pendleton to nearly \$700 million at Bechers Bay.

Timing to Operation

The reasons why it would take different lengths of time to obtain approvals and put a terminal into operation at different sites are presented in Section V. The minimum possible time to terminal operation from a decision to pursue approvals would be about 6-7 years. This time must provide for detailed site data preparation and design work, environmental impact statement preparation, many regulatory approvals, financing, construction, passage of new enabling legislation for sites on the federal outer continental shelf and, for all sites, passage of state enabling legislation. These minimum timing estimates require a "bandwagon" of support for an offshore LNG terminal and minimal opposition. The opposition of key agencies or parties with veto power or strong influence with permitting agencies could substantially extend or prevent eventual terminal approval.

Preliminary Overall Judgment

After looking at these evaluations, the southeast Ventura Flats site with a floating type terminal seems to have the least disadvantages and thus is judged to be most appropriate. A deep water subsea bottom-supported terminal on this site could be appropriate if it can meet geotechnical requirements. Overall, the northwest Ventura Flats site with a floating or subsea bottom-supported terminal seems less appropriate with its severe onshore pipeline impacts and status as a leased petroleum development area already. The terminals at sites off Deer Canyon and Camp Pendleton also appear less appropriate due to shorter distances from people, and conflict with recreation and military uses of the coast. These and the other mainland nearshore sites mentioned above should be studied in more detail if Federal offshore LNG siting legislation is not adopted. The cumulative disadvantages of the sites on or near the Santa Barbara Channel Islands appear unacceptable, except for the small siting zone just beyond three miles off Chinese Harbor at Santa Cruz Island, which seems barely acceptable.

The following steps would serve to initiate the process of developing a terminal on the Ventura Flats site:

1. The State would lend its support to the offshore siting provisions of the Biaggi Bill, HR 11365, to establish a Federal permit process in the Department of Transportation for offshore terminals.
2. The State would amend the Liquefied Natural Gas Terminal Act of 1977 to allow granting a permit for an offshore site. Such amendments should establish a basis for a joint State and Federal permit review process, and provide for consultation with the Department of Transportation in the drafting of appropriate regulations.
3. The applicant for the Little Cojo terminal would be required to submit an amended application under Article 18 of the CPUC Order of July 31, 1978.
4. Detailed pre-application geological, biological and other studies as needed would be undertaken for the SE Ventura Flats area, either by the applicant or by the State at the applicant's expense.